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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Oil And Natural Gas From Alaska, Canada, And Mexico--Only Limited Help For U. S.

The gap between U.S. oil and natural gas consumption and production is expected to continue, even widen during the 1980s. Although Alaska's resources appear promising, minimum time for development will limit its contribution. Canadian oil exports are being phased out, and its optimistic gas potential is not expected to result in large exports in this century. Mexico will probably become a primary source of U.S. oil imports over the next decade. Even so, anticipated oil and gas from Alaska, Canada, and Mexico will not be sufficient to offset anticipated domestic production declines.

Synfuels probably will not alleviate the decline in U.S. production development during the 1980s. Unconventional gas production, however, appears to offer higher potential for development in this time frame.

UNITED STATES GENERAL ACCOUNTING OFFICE

EMD-80-72

SEPTEMBER 11, 1980

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B- 199896

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses, in relation to the overall U.S. oil and gas situation, the estimated potential of oil and natural gas resources available to the United States from Alaska, Canada, and Mexico through the year 2000. The United States has experienced a significant decline in domestic petroleum output since 1971. Increasing oil and gas imports have filled the void between demand and domestic supply, and currently over 40 percent of domestic petroleum needs are being met by imports. Recent discoveries of oil and gas in Alaska, Canada, and Mexico may affect both the quantity and cost of oil and gas available for U.S. consumption during the rest of this century and beyond. These developments will, in turn, seriously affect national energy policy.

We are sending copies of this report to the Director, Office of Management and Budget, the Secretary of Energy, and the Secretary of State.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

OIL AND NATURAL GAS FROM ALASKA, CANADA, AND MEXICO--ONLY LIMITED HELP FOR U.S.

D I G E S T

The United States is 75 percent dependent on oil and natural gas for energy, and options to change this percentage or supplement declining oil and natural gas sources require long lead times for implementation. Import dependency will remain with us through the 1980s and 1990s, and we will have to work to conserve and to increase our domestic production of energy, especially oil and gas, as much as possible until our long-range energy objectives of renewable and inexhaustible energy sources are attained.

ALASKAN POTENTIAL

GAO's estimates of domestic production include projections for Alaska, our most resource-rich State. The Federal Government, as owner of most of the land in the State, must decide whether or not to develop these resources.

Because time is needed to issue leases, explore and develop drilling sites, build transportation systems, and bring production on line, the outlook for increased oil and gas supplies from Alaska through at least 1985 is limited. About 5 to 7 percent of current domestic consumption of oil comes from Alaska, practically all of it from Prudhoe Bay. Even if the result of the December 1979 Beaufort Sea Lease Sale is upheld, and oil is discovered, the oil would not start flowing until 1987 or later, by which time it would probably be needed to replace declining production from Prudhoe Bay. (See pp. 16 to 19.)

Although over 26 trillion cubic feet of natural gas is available from Prudhoe Bay, a pipeline is needed to transport this gas to market. The pipeline is not likely to be complete before 1985. When it is functional, it will deliver between 2 and 2.4 billion cubic feet of natural gas per day, about 5 percent of current consumption. The pipeline route will

be through Canada, which will provide it with supplemental supplies. (See pp. 20 to 24.)

CANADIAN POTENTIAL

Supplemental gas from Canada will not, in the aggregate, significantly help meet U.S. demand and may be eventually cut off. Canada is committed to energy self-reliance, and will make every effort to use or reserve its oil and gas for internal use. Any oil or gas from Canada will be subject to contracts of 6 years' or less duration and priced at or above world levels of oil equivalent.

Oil exports from Canada will continue to be phased out through 1981, and then the United States will receive only limited amounts of heavy crude, although a small volume of exchanges of light crude across the border will continue. Starting in the mid-1980s, the flow of heavy crude, important to our Northern Tier States, will be reduced as Canada's internal programs absorb this surplus. A west-to-east pipeline system should be in place by this time if Canadian oil is to be replaced by Alaskan oil in the Northern Tier. (See pp. 27 to 31.)

The optimistic outlook for Canadian natural gas notwithstanding, exports to the United States will not increase significantly. Existing contracts are expected to be renegotiated, but will be of only 7 or 8 years' duration. Canadian gas exports are expected to maintain their current market position of about 5 percent through the 1980s, but after 1990 they will begin to decline until phased out by 1995 as Canada's consumption increases. (See pp. 31 to 41.)

Canada has proceeded ahead of the United States on the Alaska Highway Gas Pipeline Project. Pre-building of the Canadian portion has been approved, based on a U.S. commitment to completion of the whole project. However, financing of the project must still be worked out. Timely action on the project by the United States could result in some increased imports of Canadian gas within the next 5 to 8 years

through the southern portion of the proposed pipeline. (See pp. 41 to 44.)

MEXICAN POTENTIAL

Mexico will probably be one of our primary sources of oil before the year 2000, but will not totally solve our oil deficiency problems.

Proved reserves are not a limitation on development of Mexican oil. The Mexican government has indicated a preference for a conservative oil and gas production policy based on the perceived ability of the Mexican economy to absorb these oil and gas revenues without causing excessive inflation. (See pp. 50 to 52.)

Mexico has large natural gas reserves, many of which are associated with cil. However, the opportunity to import any significant amount of natural gas from Mexico is still uncertain. The Mexican government has embarked on a program to use as much of its natural gas production as possible internally, leaving the surplus for export. The success of Mexico's program has been excellent, primarily due to the subsidized price of the gas to Mexican industry. Internal consumption is expected to increase as the pipeline infrastructure within Mexico is enlarged. (See pp. 59 to 63.)

Additionally, the contract between PEMEX, the government-owned petroleum monopoly, and six U.S. gas companies requires construction of new pipeline facilities between the two countries if virtually any increase in the existing import quantity is negotiated. The capacity of the proposed pipeline will certainly be a significant factor in the ultimate potential of Mexican gas imports. (See pp. 63 to 66.)

As a developing country, Mexico faces many problems in attaining its stated production objectives, and much of the information available for analysis is supplied only by PEMEX. For nationalistic reasons, Mexico has limited the involvement of non-Mexican firms in the development of its resources. (See p. 49.)

All of this contributes to the uncertainty of the basis for projecting the availability of Mexican oil and gas for export.

GAO OBSERVATIONS

GAO makes the following observations as a result of this analysis.

1. U.S. bilateral relationships with Canada and Mexico will directly affect U.S. access to surplus production of oil and natural gas in those countries. One factor in creating the most cooperative bilateral relationships would be for U.S. policymakers to give careful consideration to the domestic energy policies of Mexico and Canada.

2. The gap between domestic consumption and production of conventional oil and gas can be expected to widen during the 1980s and 1990s, and our import dependency can be expected to continue. This observation is made with consideration of Alaskan production, which, regardless of how promising it may appear to be, requires long lead times for production to come on line and is subject to uncertainty.

3. Concentrated effort should be made to increase our domestic production, including the development of synthetic fuels, and unconventional oil and gas resources.

4. The United States has to work to conserve more, and utilize as efficiently as possible our domestic supplies to enable us to get through the 1980s and 1990s.

5. The decline in domestic production cannot be offset by synfuels development during the 1980s and 1990s because of lead times and other constraints, but unconventional gas appears to offer more promise because several technologies are already operational on a commercial basis. We must recognize our vulnerability caused by import dependency and insure that through the Strategic Petroleum Reserve or other suitable means we have the physical ability to deal with supply disruptions. (See p. 85.)

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ABBREVIATIONS

BBO	billion barrels of oil
Bcf	billion cubic feet
Btu	British thermal unit
CIA	Central Intelligence Agency
CRS	Congressional Research Service
DOE	Department of Energy
ERA	Economic Regulatory Administration
FERC	Federal Energy Regulatory Commission
GAO	General Accounting Office
Mcf	thousand cubic feet
MMB/D	million barrels per day
MMcf	million cubic feet
NEB	Canadian National Energy Board
OPEC	Organization of Petroleum Exporting Countries
PEMEX	Petroleos Mexicanos, Mexican National Oil Company
Tcf	trillion cubic feet
USGS	U.S. Geological Survey

CHAPTER 1

INTRODUCTION

In late 1978 and early 1979, the loss of several million barrels per day (MMB/D) of oil exports to the world market from Iran demonstrated, for the second time in a decade, the precipitous balance between world supply and demand for oil. As in the 1973-1974 Arab embargo, the market reacted to the Iranian situation by sharply bidding up the spot market price of oil. Within months, oil-producing countries adjusted contract prices significantly upwards. How much higher prices will rise is still uncertain.

The oil embargo of 1973-1974 was a historic event in the energy history of the United States. Decisionmakers in and out of Government have consistently disagreed on the significance of the event, and have been unable to construct a clear picture of the new situation facing the United States and the Western World. Combining a wide range of technical problems and conflicting economic, political, and regional interests, experts have provided a confusing array of forecasts based upon still-developing methods of economic forecasting. The result has been widespread uncertainty, with the lessons of the oil embargo being largely ignored.

The Iranian curtailment may have shocked the economy to its senses. There is a growing realization that whatever the final outcome of the Iranian shortfall and its related price rises, the outlook for oil supplies over the next several years is not good. The Central Intelligence Agency (CIA) has stated, after an extensive review of the world oil situation, that "total oil supplies available to the Western industrial countries (over the next few years) are unlikely to increase significantly and may well fall." 1/

As the largest consumer of these supplies, drawing about 50 percent of its energy consumption from oil, the United States will be among the most severely affected nations. As a result, energy forecasts are being reconsidered. As of this writing few new forecasts have been completed, but there are strong indications that analysts are making

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1/U.S. Central Intelligence Agency, "The World Oil Market in the Years Ahead," National Foreign Assessment Center, ER 79-10327U, Aug. 1979, p. 2.

much more conservative assessments of remaining resources, production capacities, and available supplies of oil and gas to the United States.

The United States has experienced a net decline in domestic petroleum output since 1970. Steadily increasing oil and gas imports have filled in the growing void between demand and domestic supply, so that at the end of 1978 about 44 percent of domestic needs were being met by imports.

Recent significant discoveries of oil and gas in Alaska, our largest and most energy-abundant State, and in Canada and Mexico may affect both the quantity and cost of oil and gas imported to the United States, which could in turn help determine national energy policy. However, oil and natural gas from Alaska, Canada, and Mexico are just a small part of the overall energy problem facing America. The continued threat to U.S. security and economic viability because of our dependence on imported oil from increasingly less stable parts of the world must be mitigated during the mid-term (1985-2000). The mid-term will be a transitional period to the long-term energy alternatives of renewable and inexhaustible sources, and is likely to be marked by major conservation efforts and the rise in use of more immediate energy alternatives which offer the United States the opportunity to directly influence its own energy future. These alternatives include synthetic oil and gas, enhanced recovery of conventional sources of oil and gas, and increased use of coal, nuclear, and renewable sources like solar and geothermal energy.

This report does not, however, discuss the advantages or disadvantages of each of these energy sources. It is important to view our findings in the perspective of the overall energy situation facing the United States during the rest of this century, so as not to overplay the longer term significance of these three specific potential sources of oil and natural gas.

As has been previously stated in our reports, the U.S. national energy policy must rest on a variety of considerations. Energy issues are complex, and resolution of one problem is necessarily interrelated and interdependent with other major energy issues. A proposed resolution of one issue may overlook possible solutions proposed in other issue areas (such as conservation, nuclear energy, and solar energy), or even create several new problems in the process of resolving one. We recognize that there are a variety of answers for which support is available. The solution selected will depend on policy and economics, and must, of course, be subject to revision as changing events may dictate.

REPORT OBJECTIVES

There is strong congressional interest in the potential effect of Alaskan, Canadian, and Mexican oil and gas development on our domestic energy situation and energy policies.

The primary purpose of our review was to examine the important factors affecting the ability and willingness of Canada and Mexico to provide increased quantities of oil and gas to the United States. Although much has been written on various aspects of potential oil and gas supplies from Canada and Mexico, this report is intended to provide the Congress with a perspective on our domestic supply and consumption of oil and gas, as well as the factors affecting oil and gas policy decisions in Canada and Mexico. In presenting Canadian and Mexican government views, we do not endorse the validity of their positions nor consider them fixed in regard to future policies.

METHODOLOGY AND SCOPE OF THE REVIEW

In order to assess the effect of these potential supplies on our energy situation and Federal energy policies, it is necessary to evaluate how much oil and gas will be available, when, and for how long. The quantity of oil and gas available to the United States and the delivery rate of this quantity are essential parts of our analysis. Many elements go into the forecast of deliverable quantities of oil and gas, and estimates vary considerably on each potential source considered. We believe that our assessment is reasonable based on the scope of our analysis, and is sufficiently accurate to allow an evaluation of national energy policy.

Similarly, we have attempted to estimate the border prices of imports of oil and gas from Canada and Mexico, and the costs of Alaskan oil and gas to the lower 48 States. Costs of oil and gas from the sources relative to domestic costs and other imports will dictate the acceptability in the marketplace of these imports and Alaska's potential contribution. Given the relative scarcity of oil and gas, however, price is not likely to have significant impact on the results of our analysis until the price of alternate energy forms is competitive with that of oil and gas, or demand is effectively reduced by conservation efforts.

In addition to the complex economic variables that will affect the availability of oil and gas from Alaska, Canada, and Mexico, we have considered the potential impact of energy policy in Canada and Mexico on the availability and security of supplies. Subjectively, and to a limited extent, we have

also considered the potential impact of politics between the United States and its contiguous neighbors.

During this review we interviewed and obtained information from Department of Energy (DOE), Department of State, and other Federal agency officials, as well as industry spokesmen on Alaskan, Canadian, and Mexican oil and gas reserves. These officials and industry representatives also provided background information related to the energy situation in each area, and on U.S. energy trade relations with Canada and Mexico.

Our analysis includes information from and discussions with officials knowledgeable of the energy situation in each area. In Alaska, we met with State energy officials and representatives from the oil and gas industry, including the company with the largest oil and gas interests in Alaska's producing areas. In Canada we met with federal and provincial energy officials, and representatives from several oil and gas companies and industry organizations.

At the Department of State's request, we did not go to Mexico. We held discussions with Mexican embassy officials in Washington, D.C. We also interviewed officials from the U.S. companies forming the consortium to purchase Mexican gas, and from the engineering consulting firm which assists Mexico's national petroleum company, PEMEX, in evaluating Mexico's oil and gas reserves.

Our projections of U.S. supply and consumption of oil and gas are based in part on several recently published studies which take into account the Iranian shortfall and the subsequent Organization of Petroleum Exporting Countries (OPEC) pricing activities, and on our 1979 report on trends in domestic oil and natural gas production. 1/ Statistical information was obtained from Government and industry sources, and from published literature. The information contained in this report is also based on our work in the areas of oil and gas over the past several years, some of which we published in previous reports to the Congress.

The future supply estimates contained in this report were either obtained from previously published studies or are based on such studies. We have made no attempt to determine their accuracy beyond a test of reasonableness. We believe that those included reasonably project the potential supply

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1/"Analysis of Current Trends in U.S. Petroleum and Natural Gas Production," EMD-80-24, Dec. 7, 1979.

of oil and gas from Alaska, Canada, and Mexico, and the outlook for domestic production. The estimates of future supply and consumption presented herein are not definitive forecasts, but are intended as a reasonable basis for our analysis and national energy policy evaluation.

CHAPTER 2

ALASKAN RESOURCES: POTENTIAL SUPPLIES ARE VAST BUT SHORT-TERM DEVELOPMENT WILL BE LIMITED

Alaska is our most resource-rich State. The United States Geological Survey (USGS) reports that Alaska holds between 12 and 49 billion barrels (BBO) of undiscovered, recoverable crude oil and between 29 and 132 trillion cubic feet (Tcf) of undiscovered, recoverable natural gas. Added to already proved recoverable reserves, Alaska's recoverable totals become 22 to 59 BBO and 61 to 164 Tcf of natural gas.

However, there is very little chance that the State's oil or natural gas production can be significantly increased beyond current levels prior to 1985. Before new resources can be made available to consumers, time will be needed to issue leases, search for oil and gas in unexplored areas, set up transportation systems, and begin production from areas where reserves are known to exist. These procedures could take up to 10 years for undiscovered oil and natural gas. Natural gas from proved Prudhoe Bay reservoirs will not be available until the completion of the proposed Alaska Highway Pipeline Project.

The oil and gas industry with its sophisticated exploration and production techniques has yet to move aggressively into Alaska. According to one major oil company, economics, politics, and the previous availability of cheap energy from elsewhere have combined to inhibit Alaska's resource development. As the United States faces restricted oil imports and reduced domestic production, the Congress must decide on the extent to which Alaska should be developed to reduce the difference between our energy demand and domestic supply.

HISTORY OF OIL AND NATURAL GAS EXPLORATION AND DEVELOPMENT

Alaska was known to contain oil prior to the 19th century. Its first economically significant oil field was Katalla on the north coast of the Gulf of Alaska. Between 1907 and 1933, this field produced a total of 154,000 barrels of oil which were marketed to local fishing fleets, canneries, and mining companies.

Alaska only began exporting oil in 1960 but by the 1970s the State ranked seventh among the oil-producing States. Without question, oil became big business in Alaska with the discovery and development of Prudhoe Bay, on Alaska's North

Slope. With the added production from Prudhoe Bay, the State's November 1979 daily rate of production was 1.6 million barrels, second only to Texas.

Alaska's natural gas production history is similarly brief. Only small amounts of the State's proved natural gas reserves have been produced. Natural gas produced from southern Alaskan gas fields not used locally is liquefied and sold to Japan under a contract that will soon expire and will not be renewed. Gas produced in conjunction with the Prudhoe Bay oil operation is being reinjected into the reservoir, with a small amount being used to power reinjection equipment.

FACTORS DELAYING FURTHER OIL AND NATURAL GAS EXPLORATION AND DEVELOPMENT IN ALASKA

Since the Prudhoe Bay discovery in 1968, very little of Alaska has been leased for exploration and no major discoveries have been made. Problems reported by oil companies operating in Alaska include high taxes, limited land available for exploration and development, dry holes where drilling has been permitted, the high cost of Alaskan operations, the high cost of transporting resources which have been developed to market, and perceived competition from Mexico. A brief description of each issue follows.

Taxation

Alaska's State and local tax burden on the oil industry is higher than in other oil-producing States. (See fig. 2.1.) According to the Alaska Oil and Gas Association, oil companies operating in Alaska pay more in taxes, both in terms of percent of income and total dollars, than any other Alaskan business. Despite complaints about Alaska's tax burden, oil company executives informed us that the taxes are not sufficient to prohibit operations, but in the past contributed to making operations marginal.

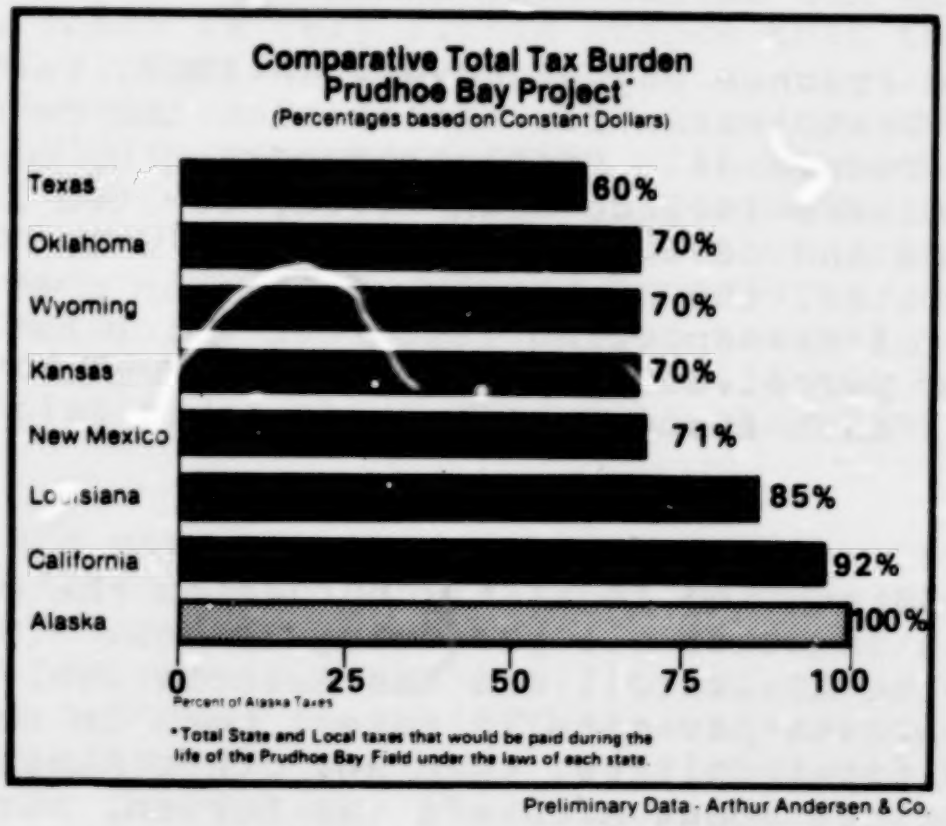
A representative of the State of Alaska's Department of Revenue informed us that the State's tax structure is one of the more progressive and fair taxing systems in the country. The State's major taxes, income and severance, are based largely on profitability and are designed to encourage development of marginal fields. The representative believed that oil company pronouncements on taxation tend to be overstated.

Alaska estimated that taxes and royalties gathered from the oil industry would total $790 million during 1979, or

58 percent of the State's total income. If Federal grants and other funds whose use is restricted were not counted, the oil and gas contributions to the State's income in 1979 would be 74 percent.

Alaska expects to collect $1.4 billion in fiscal year 1980 (July 1, 1979, to June 30, 1980) from petroleum royalties and taxes. The high income will result from the increased world price of oil and the commitment by North Slope producers to pay a higher price for the oil at the wellhead. Another factor is the increase in trans-Alaska pipeline "throughput" to 1.5 MMB/D during 1980.

FIGURE 2.1



SOURCE: "THE FUTURE OF ALASKA--WHAT ALASKANS SHOULD KNOW ABOUT JOBS, RESOURCES AND GOVERNMENT," BY THE ALASKA OIL AND GAS ASSOCIATION.

Land available for exploration and development is limited

On the mainland of Alaska, less than 3,150 square miles out of 586,400 square miles have been leased for exploration. Oil company executives blame the Federal and Alaskan bureaucracies for not opening more land to exploration, as much of the State is under Government control.

Prior to becoming a State, nearly all of Alaska was under Federal control. The Alaska Statehood Act of 1958 (72 stat. 339) granted the State the right to choose 161,485 square miles of the 585;935 square miles of Federal land for State ownership. In its first round of selections, the State chose the oil-rich lands around Prudhoe Bay. The State's position is that it is possible to develop oil and natural gas for use by the rest of the Nation without inflicting harm upon its environmental and recreational resources.

To date, Alaska has received patent to just 32,813 of the 161,485 square miles. In 1971, the Congress awarded an additional 68,750 square miles to Alaska'a native peoples, but thus far they have received only 10,937 square miles. According to an Alaska State official, until the ownership issue is settled, the land will not be leased by the oil companies for exploration.

Opportunities to explore for Alaska's resources continue to be limited by Presidential and congressional actions. In December 1978, some 171,878 square miles of federally owned Alaskan lands (nearly one-third of the State) were placed under temporary wraps as wilderness areas and national monuments, making them off-limits to exploration and development. Besides closing these lands to exploration and development, this action also closed them as access routes to regions where oil and gas might be found. This raises the possibility of a significant oil and gas discovery not being developed because transportation routes to markets are blocked. Figure 2.2 shows the large areas of Alaska that are closed or soon could be closed to energy extraction. Most of this land is, or is being considered for, Federal and State parks, wilderness areas, Native selection lands, or some other restricted withdrawal.

Offshore, two-thirds of the continental shelf of the United States adjoins Alaska. However, the only completed Federal lease sales have been in the Gulf of Alaska and Lower Cook Inlet. Some of the highest-potential energy resource areas such as the St. George Basin and Bristol Bay are not available for leasing because they are prime fishing grounds.

The Bureau of Land Management's scheduled Outer Continental Shelf lease sales off Alaska are as follows:

Beaufort Sea	-	December 1979
Gulf of Alaska	-	June 1980
Kodiak	-	October 1980
Cook Inlet	-	March 1981
Bering-Norton Sea	-	December 1981

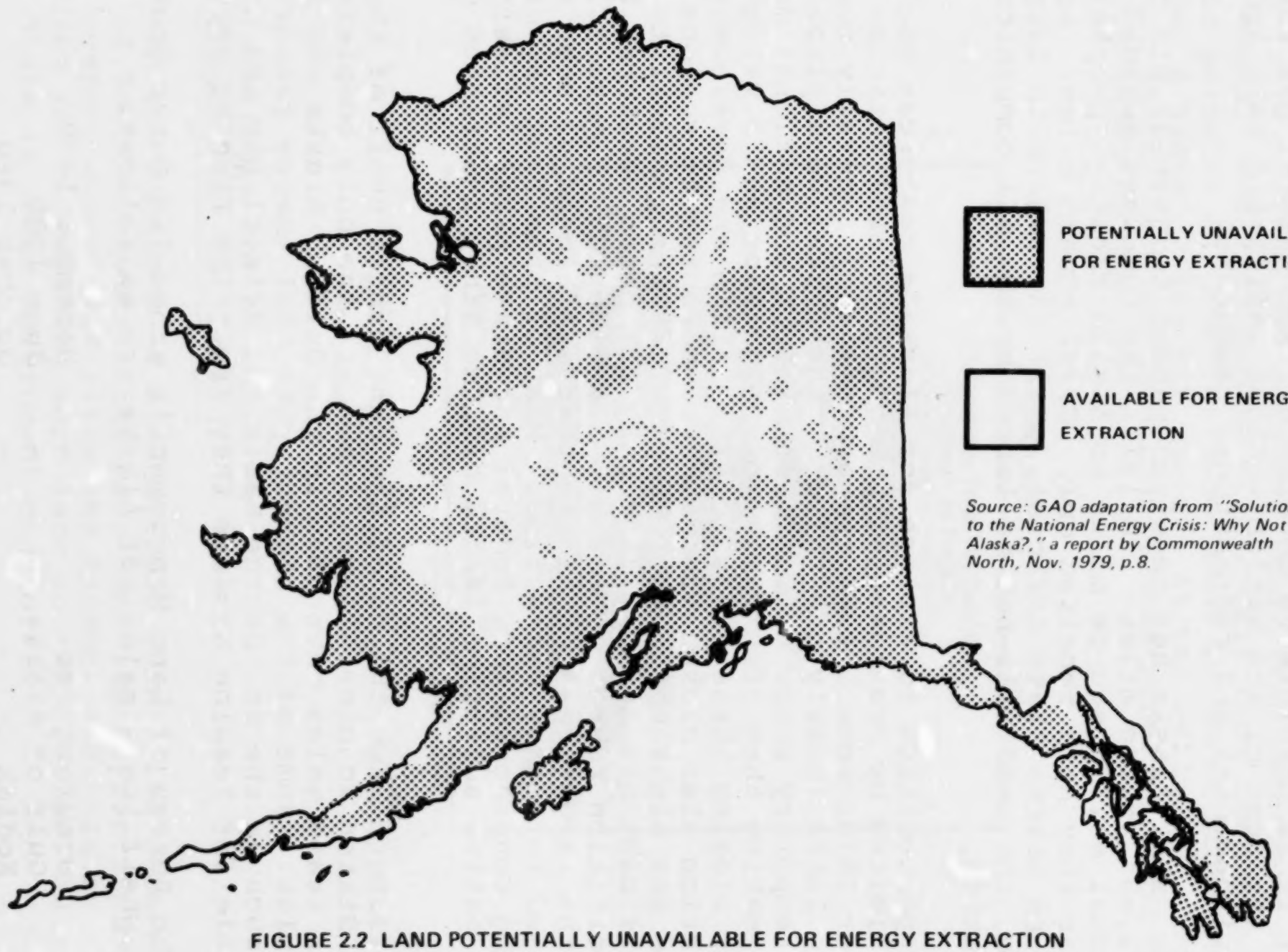

POTENTIALLY UNAVAILABLE FOR ENERGY EXTRACTION
AVAILABLE FOR ENERGY EXTRACTION
Source: GAO adaptation from "Solutions to the National Energy Crisis: Why Not Alaska?," a report by Commonwealth North, Nov. 1979, p.8.

FIGURE 2.2 LAND POTENTIALLY UNAVAILABLE FOR ENERGY EXTRACTION

Lease sales are contingent upon technology being available for exploration and development. The lease sales listed cannot be allowed until the completion of necessary studies of the environmental impact; as a result of these procedures, a decision may be made to cancel any scheduled sale. In December 1979 the oil industry offered Alaska and the Federal Government nearly $2.1 billion in immediate cash for rights to drill for oil and gas in the Beaufort Sea. Oil industry interest in the sale was extremely high because of the recent oil discoveries in the Canadian Beaufort Sea and the proximity of the tract to Prudhoe Bay. Although a U.S. District Court judge temporarily enjoined any lease sales because of a challenge brought by Eskimos concerned about effects on the environment, the injunction was vacated by the U.S. Court of Appeals, with an opinion to follow.

The December 1979 Beaufort Sea lease sale was unique in that it was the first in Alaska involving land owned by two governments, i.e., Federal and State. In all, some 800 square miles of Outer Continental Shelf lands were nominated for leasing. The State of Alaska owns 68 percent of the nominated area. The Federal Government owns 19 percent and the remaining acreage is in dispute. (See fig. 2.3.)

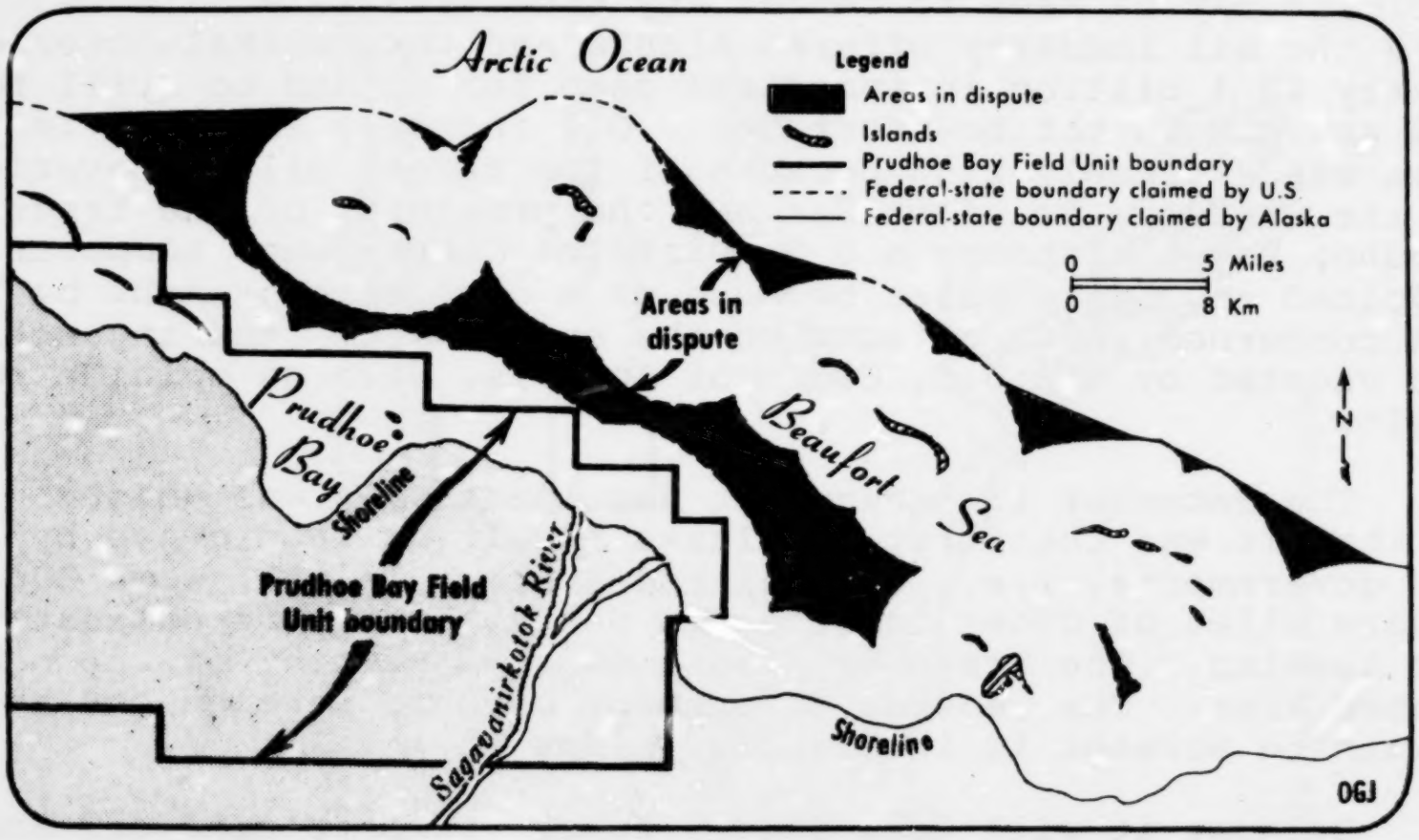
Because it will take some 8 to 10 years to find oil and begin oil production in the Beaufort Sea, completing the lease sale is extremely important to Alaska's future. Activity at Prudhoe Bay will be continuing for many years, but production from the field will begin declining around 1985. Another discovery as large as Prudhoe Bay is unlikely, but smaller fields need to be found in the Beaufort Sea to help offset the decline in Prudhoe production and associated State revenues.

Dry holes where drilling has occurred

Alaskan oil exploration consists of drilling in four areas of the State: the North Slope, the Kenai Peninsula area, Cook Inlet, and the Gulf of Alaska. With the exception of Prudhoe Bay on the North Slope, recent drilling has had either inconclusive or disappointing results.

North Slope exploration results were disappointing until March 1968, when an Atlantic Richfield team confirmed a successful oil well at Prudhoe Bay. After considering different methods for transporting the oil to the lower 48 States, plans were made to construct a pipeline from Prudhoe Bay to Valdez on Alaska's southern coast. From that point tankers would carry the oil to U.S. refineries. Before pipeline construction

FIGURE 2.3
DISPUTED ALASKA U.S. OWNERSHIP IN BEAUFORT SEA



SOURCE: OIL AND GAS JOURNAL

could begin, a controversy developed between the petroleum industry and special interest groups over the pipeline's potential impact on the Alaskan environment. Five years passed before the issue could be settled, with supporters of the pipeline winning out. Oil from Prudhoe Bay finally began flowing through the pipeline in June 1977.

Recent exploration drilling at Lower Cook Inlet has been sparse. Only one well has been completed, and it had noncommercial oil "shows." Thirteen platforms in the Upper Cook Inlet have produced over 500 million barrels of oil in about 10 years, and 360 million additional barrels are expected to be recovered. There have been no recent major oil or gas finds in the Kenai Peninsula area.

All 11 holes drilled in the Gulf of Alaska were dry and have been abandoned. These results have cast a blight on the Gulf, an area that was once considered prime oil ground. The failure in the Gulf was not expected by explorationists, since many onshore oil seeps were found and seismic work indicated large potentially oil-bearing structures. But offshore there were no oil shows. Apparently not enough

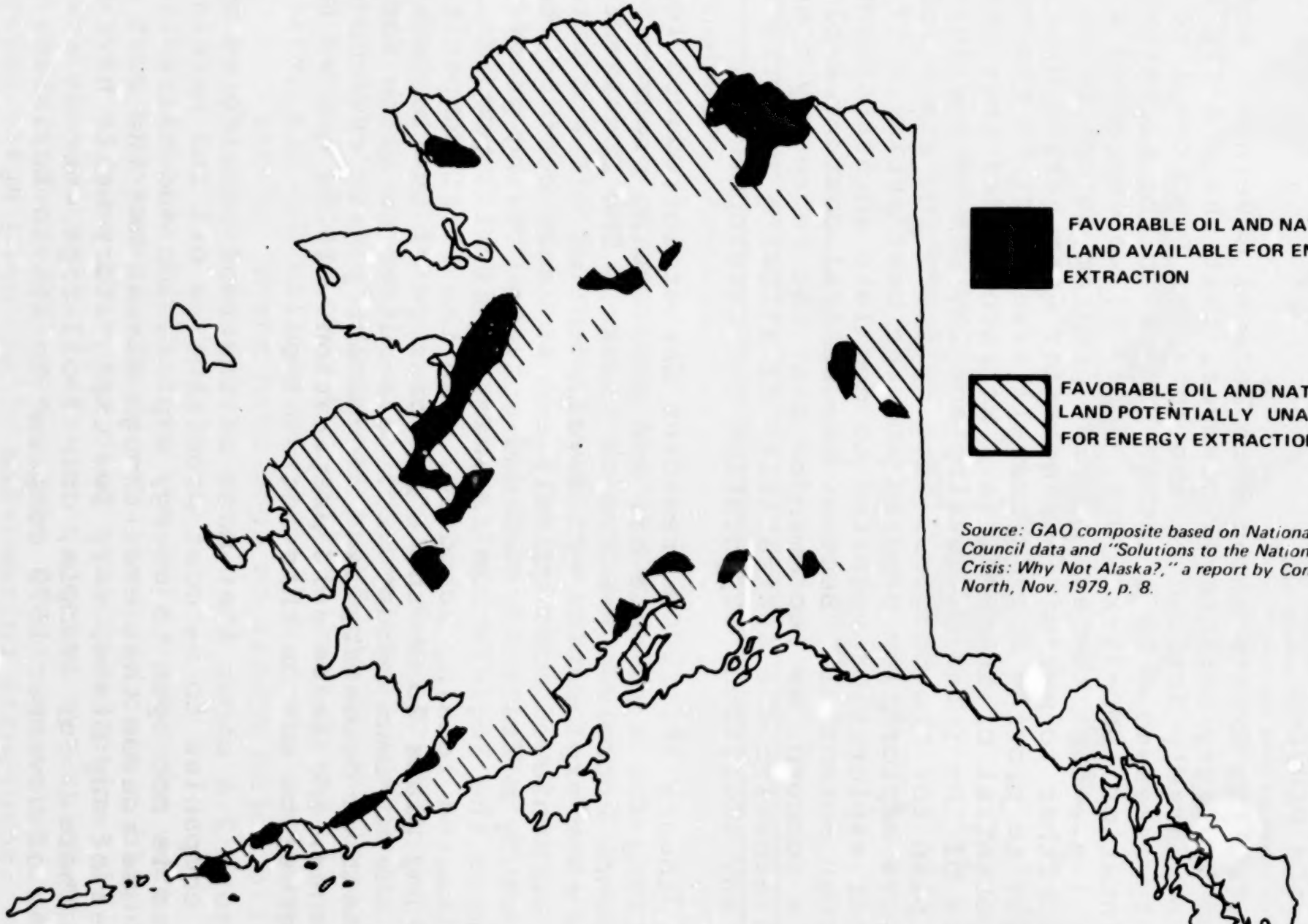
time had elapsed for the material in the structure to generate hydrocarbons.

A limited petroleum exploration program is being conducted on the National Petroleum Reserve in Alaska under the supervision of the Department of the Interior. Program results have been so disappointing that Interior is considering terminating the program.

The feeling exists among some Federal Government and petroleum industry officials, however, that the Reserve is being too sparsely drilled by the Interior Department to be thoroughly assessed. In a letter report to the Secretary of the Interior (EMD-79-13, Dec. 5, 1978) we expressed a similar opinion, i.e., that the exploration program is not being directed either to maximize chances for discovering hydrocarbons or to provide for an overall assessment of the hydrocarbon potential of the Reserve. We recommended that the Secretary of the Interior develop and lay out an explicit overall plan for the Congress setting forth the status of the Reserve exploration program and the best estimate of the additional exploration required to complete an assessment of hydrocarbon potential. Because the Federal cost of exploration is a concern, we recommended that the Secretary consider as an alternative the desirability of allowing industry to conduct any additional exploration and development.

On January 28, 1980, President Carter introduced legislation calling for a private oil and gas leasing program for the National Petroleum Reserve in Alaska. The President believes that exploration and development of oil and natural gas can be achieved most quickly and at least cost to the Government by a federally managed private leasing program. If and when the legislation is enacted, it will provide for an accelerated leasing schedule, with the first competitive bids taking place 20 months after passage of the legislation. This is the minimum amount of time required to allow for development of necessary land management plans, environmental assessments, and lease sale preparation. It is now up to the Congress to act on this legislation.

Figure 2.4 shows that most of the land considered by the oil companies to be most promising as oil and natural gas areas is not open to energy exploration and extraction. This is one reason that even though Alaska has the most oil potential of any State, very few exploratory wells have been drilled there. For example, only 7 oil rigs were at work in Alaska as of November 1979 compared to 366 in Louisiana and


FAVORABLE OIL AND NATURAL GAS LAND AVAILABLE FOR ENERGY EXTRACTION
FAVORABLE OIL AND NATURAL GAS LAND POTENTIALLY UNAVAILABLE FOR ENERGY EXTRACTION

Source: GAO composite based on National Petroleum Council data and "Solutions to the National Energy Crisis: Why Not Alaska?," a report by Commonwealth North, Nov. 1979, p. 8.

FIGURE 2.4 AVAILABILITY OF FAVORABLE OIL AND NATURAL GAS LANDS FOR ENERGY EXTRACTION

807 in Texas. A report prepared by Alaska's Department of Natural Resources concludes that with current economic, royalty, and tax conditions, the minimum-size field that an oil and gas operator can afford to develop in Alaska must have the potential to produce in excess of 55 million barrels of oil in close areas such as Cook Inlet and 100 million barrels or more in remote areas. To put this point into perspective, on a nationwide basis, the vast majority of new discoveries are under 1 million barrels, but over 70 percent of all the oil ever found in the United States has been in fields larger than 100 million barrels.

High cost of Alaskan exploration operations

Alaskan exploration wells are very expensive, because of the high costs of getting drilling equipment to work sites and the short exploration season (6 months or less is common). Wells started during one season may have to be suspended and finished the following year.

The average cost of an exploration well in the lower 48 States is about $112,000. The average exploration well on the North Slope costs $8 million to $12 million. In Cook Inlet, exploration wells cost between $3 and 5 million.

As another example, drilling for the first 2 years in the Beaufort Sea will be primarily from man-made gravel islands and not from ice islands. Gravel islands are expensive. One rule of thumb is that a gravel island will cost $1 million per foot of water depth. Thus, if a well is to be drilled in 10 feet of water, the initial outlay for the island is $10 million. Added to the $15-million cost of the well, the total cost of the operation is over $25 million.

Alaskan oil and natural gas must be transported great distances

The Alaskan market is incapable of absorbing the State's oil and natural gas production. Therefore, crude oil from Prudhoe Bay is transported via the Trans-Alaskan Pipeline System to the southern coast of Alaska where it is shipped via tankers to refineries on the West, Gulf, and East Coasts of the lower 48 States. As of June 30, 1979, pipeline tariff and shipping costs added $7 to the wellhead price of Alaskan crude to West Coast refiners and $9 to Gulf Coast refiners. These shipping costs reduce the profits to the companies and income to the State. According to one Alaskan State official, this is the reason that the Prudhoe Bay operation delayed developing the Kuparuk and Lisburne petroleum fields. The

resulting wellhead value netted back from the Gulf and East Coast sales was not sufficient to justify the further investment needed for increased operations.

Transporting Alaskan gas to the lower 48 States will also be expensive. In September 1977, President Carter and Canadian Prime Minister Trudeau selected the 4,800-mile-long Alaska Highway Gas Pipeline Project to deliver North Slope Alaskan natural gas to U.S. markets. The total cost of the proposed pipeline system is currently estimated at $23 billion, adding at least $3 to the cost of a thousand cubic feet (Mcf) of gas.

Competition from Mexico

Recent discoveries of massive oil and natural gas reservoirs in Mexico have caused petroleum company officials to question the need for developing Alaska. However, how much of Mexico's resources will be available to the United States remains an open question. (See ch. 4.) The Director of Alaska's Division of Geological and Geophysical Surveys believes that a comprehensive exploration and development program for Alaskan oil must begin now regardless of any agreements with Mexico. According to his point of view, if this country waits until an emergency energy situation arises, development of Alaska is likely to be unduly rushed, resulting in an inefficient and poorly planned program.

ALASKA'S OIL RESOURCE DEVELOPMENT POTENTIAL

Alaska means different things to different individuals. Environmentalists see it as the country's only remaining wilderness, and one that must remain pristine. To businessmen it is the last frontier, waiting to be explored for minerals, lumber, and oil. The Congress must decide which of Alaska's federally owned lands shall remain wilderness and which may be developed. Any decision reached will have an immense impact on Alaska's economy.

The available data for crude oil estimates in Alaska varies tremendously in quantity and quality depending on the area. For example, the area around Prudhoe Bay has over 100 wells, and seismic data abounds 1/; the resources of most other areas of Alaska, however, such as the Arctic National

---

1/Estimates based on seismic studies indicate the presence of potential hydrocarbon traps but do not necessarily indicate the existence of oil or natural gas resources in producible quantities.

Wildlife Refuge, have not been subjected to exploratory wells or seismic studies. Therefore any resource estimates for the Refuge and other areas are subject to a great deal more uncertainty than an estimate for Prudhoe Bay.

Prudhoe Bay

The Prudhoe Bay field on the north coast of Alaska is one of the few areas in the State where extensive drilling has occurred and reserve figures are available. According to the American Petroleum Institute and the American Gas Association, as of December 31, 1978, Prudhoe Bay held approximately 8.89 BBO of proved reserves, which is about 32 percent of the total U.S. proved reserves.

British Petroleum, Incorporated (BP), is the major owner and producer of Prudhoe Bay oil. Oil production reached an average of 1.5 MMB/D in late 1979 and according to BP officials will continue at about that production level until about 1985 when a gradual decline will begin. The 1.5-MMB/D production equals about 8 percent of the present daily U.S. consumption and about 18 percent of the country's total domestic production. By the year 2000, Prudhoe Bay production is expected to be less than 500,000 barrels per day. In developing its plan of operation, BP investigated many variations in oil extraction, gas sales, and injection. In all the cases studied, oil production of 1.5 MMB/D will optimize oil extraction. BP believes it should be possible to manage and operate the reservoir within the framework of this plan to achieve a recovery of about 40 percent of the original 23.8 BBO in place after about 25 years.

BP studies also indicate that future gas production from Prudhoe Bay will affect ultimate oil recovery only slightly. The company estimates a possible loss of oil on the order of 1 percent of the oil in place, or just over 200 million barrels over 25 years of oil production.

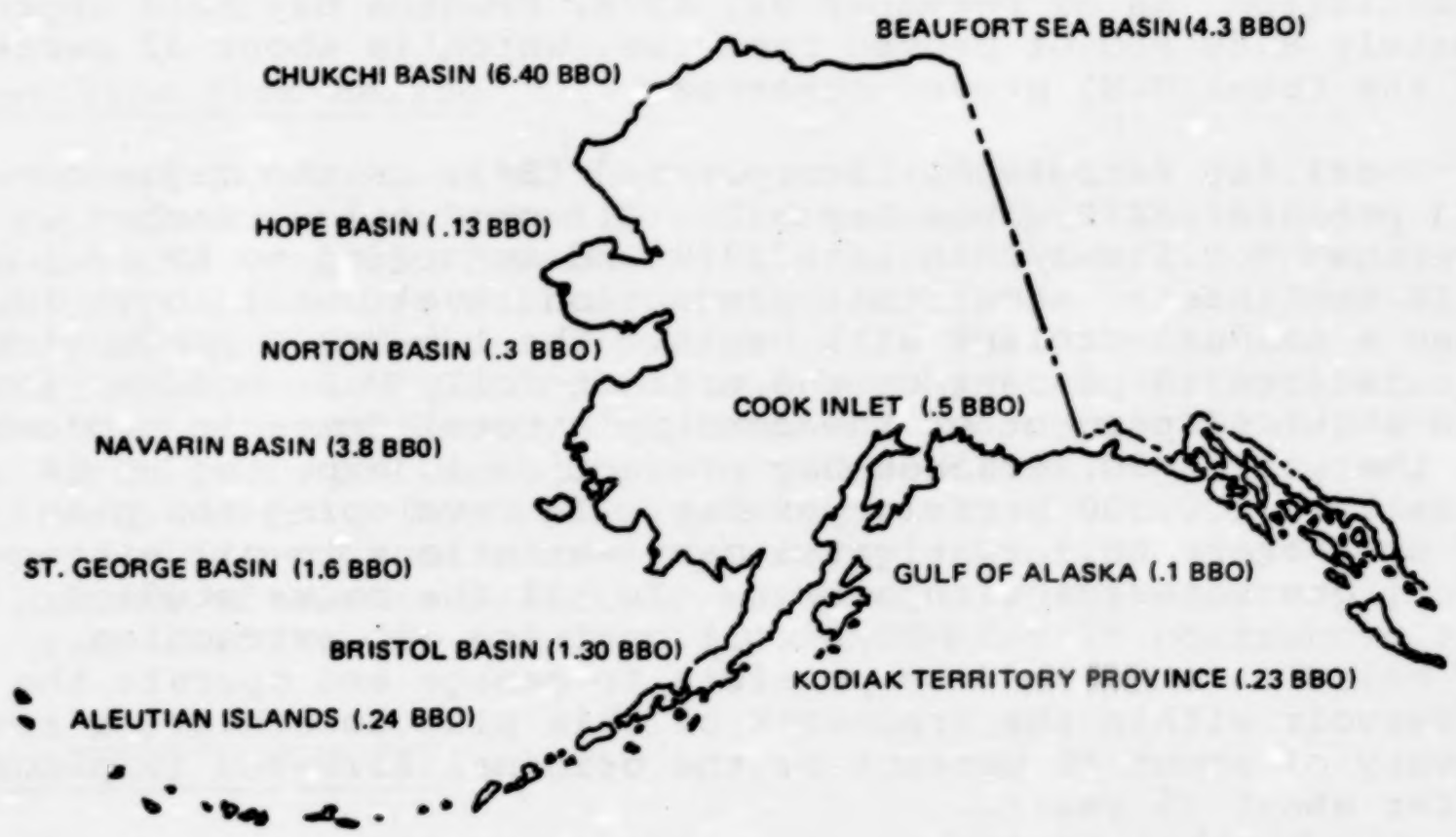
BP recognizes that the difference in oil recovery arising from hypothetical reservoir management options does not become fully apparent until after about 15 to 20 years of oil production. The company should assure the State and all interested parties that it will make whatever production adjustments are necessary to ensure that hydrocarbon recoveries are maximized.

Alaskan offshore oil resource potential

Government and industry officials agree that Alaska's offshore areas hold the greatest potential as major sources of oil supplies. However, there has been very little exploration in these areas to document their full potential. A Department

of the Interior poll of the petroleum industry showed that of the 22 Outer Continental Shelf areas in the United States that are most likely to contain oil resources, 11 were off the coast of Alaska. The resource locations and their recoverable oil potential as estimated by USGS are listed in figure 2.5.

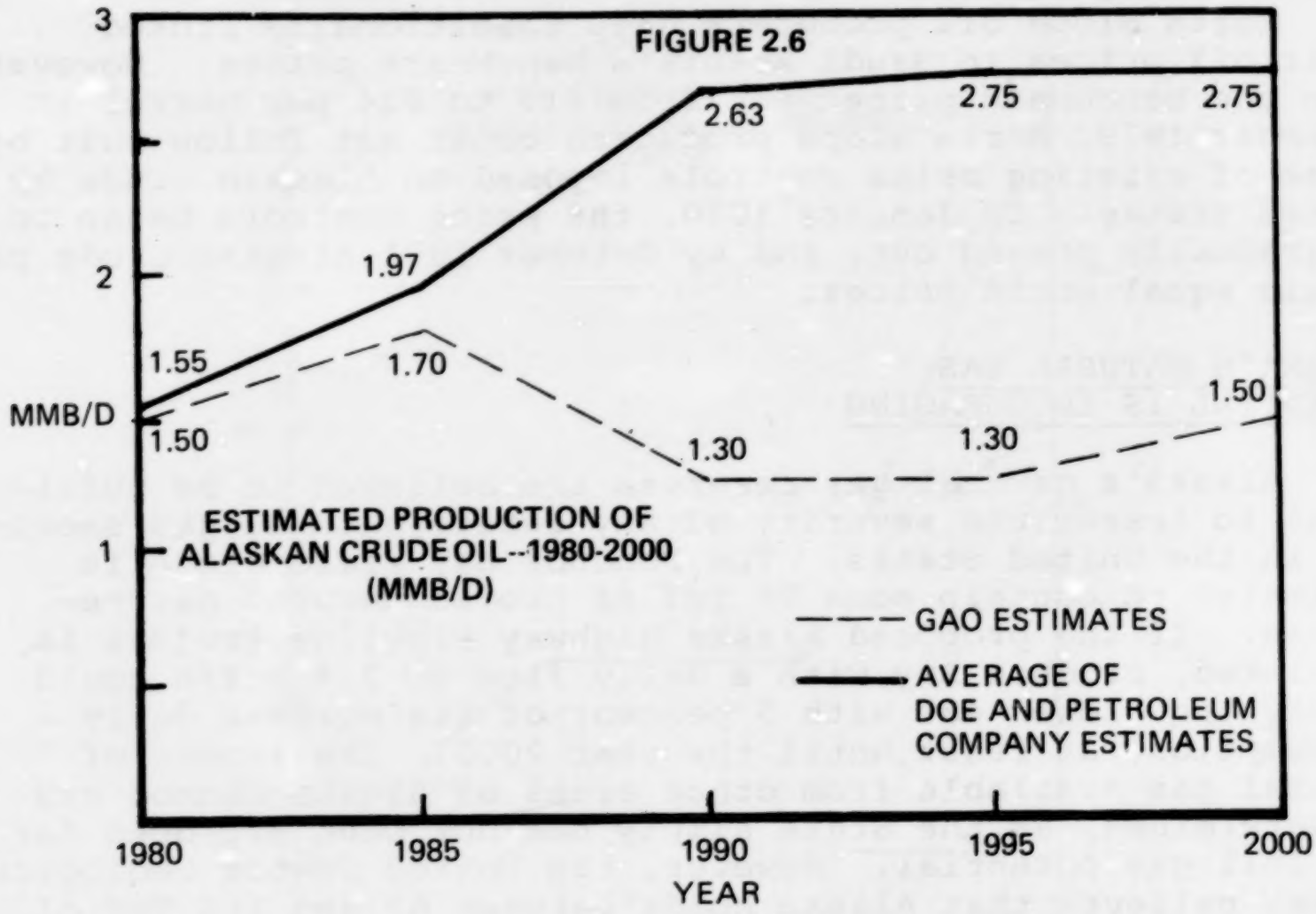
FIGURE 2.5
ALASKA OCS AREAS WITH OIL POTENTIAL


BEAUFORT SEA BASIN (4.3 BBO)
CHUKCHI BASIN (6.40 BBO)
HOPE BASIN (.13 BBO)
NORTON BASIN (.3 BBO)
COOK INLET (.5 BBO)
NAVARIN BASIN (3.8 BBO)
ST. GEORGE BASIN (1.6 BBO)
GULF OF ALASKA (.1 BBO)
BRISTOL BASIN (1.30 BBO)
KODIAK TERRITORY PROVINCE (.23 BBO)
ALEUTIAN ISLANDS (.24 BBO)

Source: USGS figures.

Alaskan oil production potential

The Department of Energy and several petroleum companies and organizations are optimistic that new oil fields will be discovered in or near Alaska, particularly in the Beaufort Sea. By averaging estimates of Alaskan production from these sources, Alaska is expected to be producing over 2 MMB/D by 1990. (See fig. 2.6.) As the capacity of the Trans-Alaska Pipeline System is now only 2 MMB/D, the problem of transporting the extra oil will have to be resolved. In reviewing figure 2.6, it is important to be aware that the average of DOE and petroleum company production figures for 1990 and beyond is based largely on developing oil resources that as of this date have not been discovered. Jf new discoveries



are not made, Alaska will be producing less than 1 million barrels per day in 1990, with production steadily declining after that.

More conservative estimates of crude oil production were developed in our report on trends in U.S. petroleum and natural gas production. 1/ Our figures show that by the 1990s Alaskan oil production will stabilize, and increase slightly at the end of the century. A large portion of the oil produced at that time will be from areas other than Prudhoe Bay.

Price of Alaskan crude oil

In January 1980, Alaskan North Slope crude oil was selling for $13.52 per barrel at the wellhead. Pipeline and shipping costs added about $9 to this price, making the delivered price to U.S. refiners about $22. At this price, Alaskan crude is now one of the most sought after in the United States, as the delivered price is anywhere from $7 to $10 a barrel below the cost of OPEC oil.

1/"Analysis of Current Trends in U.S. Petroleum and Natural Gas Production," EMD-80-24, Dec. 7, 1979.

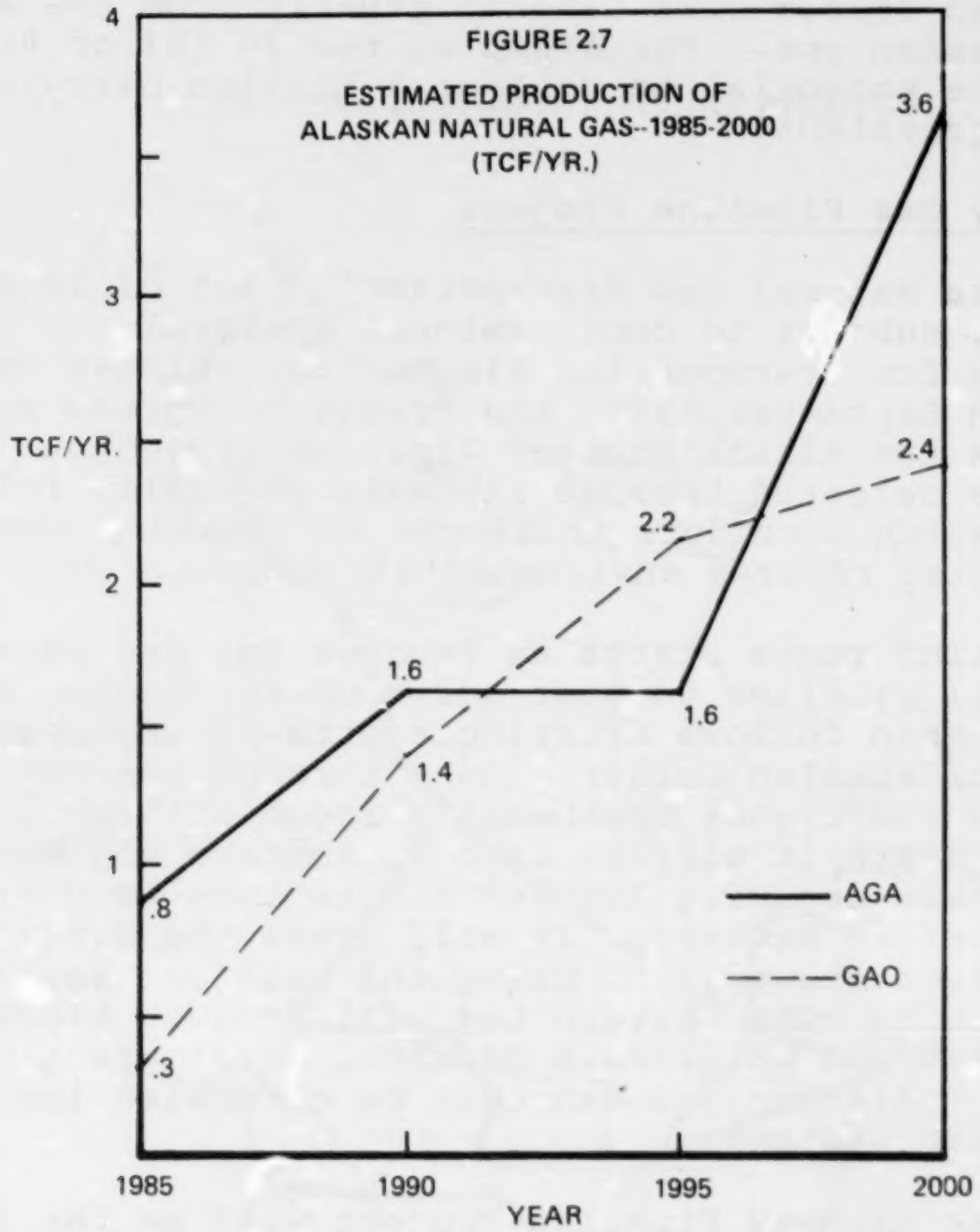
North Slope oil producers have traditionally linked their oil prices to Saudi Arabia's benchmark prices. However, when the benchmark price went from $19 to $24 per barrel in December 1979, North Slope producers could not follow suit because of existing price controls imposed on Alaskan crude by the United States. In January 1980, the price controls began to be gradually phased out, and by October 1981 Alaskan crude prices should equal world prices.

ALASKA'S NATURAL GAS POTENTIAL IS ENCOURAGING

Alaska's natural gas reserves are believed to be sufficient to lessen the severity of any future natural gas shortage in the United States. The Prudhoe Bay field alone is estimated to contain some 26 Tcf of proved natural gas reserves. If the proposed Alaska Highway Pipeline Project is completed, Prudhoe Bay with a daily flow of 2.4 Bcf/d could supply the "lower 48" with 5 percent of its current daily consumption, at least until the year 2000. The amount of natural gas available from other areas of Alaska cannot now be determined, as the State simply has not been explored for its full gas potential. However, the United States Geological Survey believes that Alaska holds between 61 and 164 Tcf of recoverable natural gas reserves.

The offshore areas of the State are expected to be major sources of new gas supplies. According to USGS, the recoverable natural gas potential of the offshore areas of Alaska includes the following:

	Natural gas potential (Tcf)
Aleutian Shelf	.88
Hope Basin	.86
Beaufort Sea	16.50
St. George Basin	6.20
Norton Basin	1.20
Chukchi Sea	19.80
Navarin Basin	14.20
Cook Inlet	1.50
Gulf of Alaska	.40
Kodiak	.69
Total	62.23



PRODUCTION OF
ALASKAN NATURAL GAS

Our analyses and those of the American Gas Association convey optimism that by 1985, Alaska could be a major producer of natural gas. However, to reach the predicted production levels (see fig. 2.7), one and possibly two major gas transportation systems will be needed to deliver the gas to markets in the lower 48 States. Also, new natural gas fields will have to be discovered and placed into operation, supplementing gas production from Prudhoe Bay.

Besides taking factors such as price, environmental standards, and leasing policy into account, our analysis of domestic gas production (see footnote, p. 19) also considered historical natural gas resource base and reserve addition profiles. While estimates for future natural gas production in Alaska are given, we believe the report is most useful as an indicator of trends in future Alaskan natural gas production.

The United States will benefit greatly from the availability of Alaskan gas. For example, the 26 Tcf of Prudhoe Bay gas has the potential to replace 5 billion barrels of oil in heat equivalent.

Alaska Highway Gas Pipeline Project

The Alaska Natural Gas Transportation Act of 1976 directs the President, subject to congressional approval, to decide upon the best route for transporting Alaskan natural gas to the lower 48 States. In September 1977, the President agreed to a proposal known as the Alaska Highway Pipeline Project. This pipeline route was selected because it would generally follow existing transportation corridors in Alaska and Canada, thereby minimizing potential adverse environmental impacts. (See fig. 2.8.)

The pipeline route starts at Prudhoe Bay and parallels the Alyeska oil pipeline to just south of Fairbanks, Alaska, and the route then follows existing rights-of-way eastward to the Alaskan/Canadian border. Once through the Yukon Territory, the route goes southeast through British Columbia into Alberta, where it divides into an Eastern and Western Leg. The Eastern Leg will deliver Alaskan gas to U.S. Midwestern and Eastern markets. It will cross the U.S./Canadian border from Saskatchewan, and bring the gas just south of Chicago, Illinois. The Western Leg will deliver Alaskan gas to the Northwest and California markets, terminating near San Francisco. Alaskan gas can then be channeled into existing gas distribution systems.

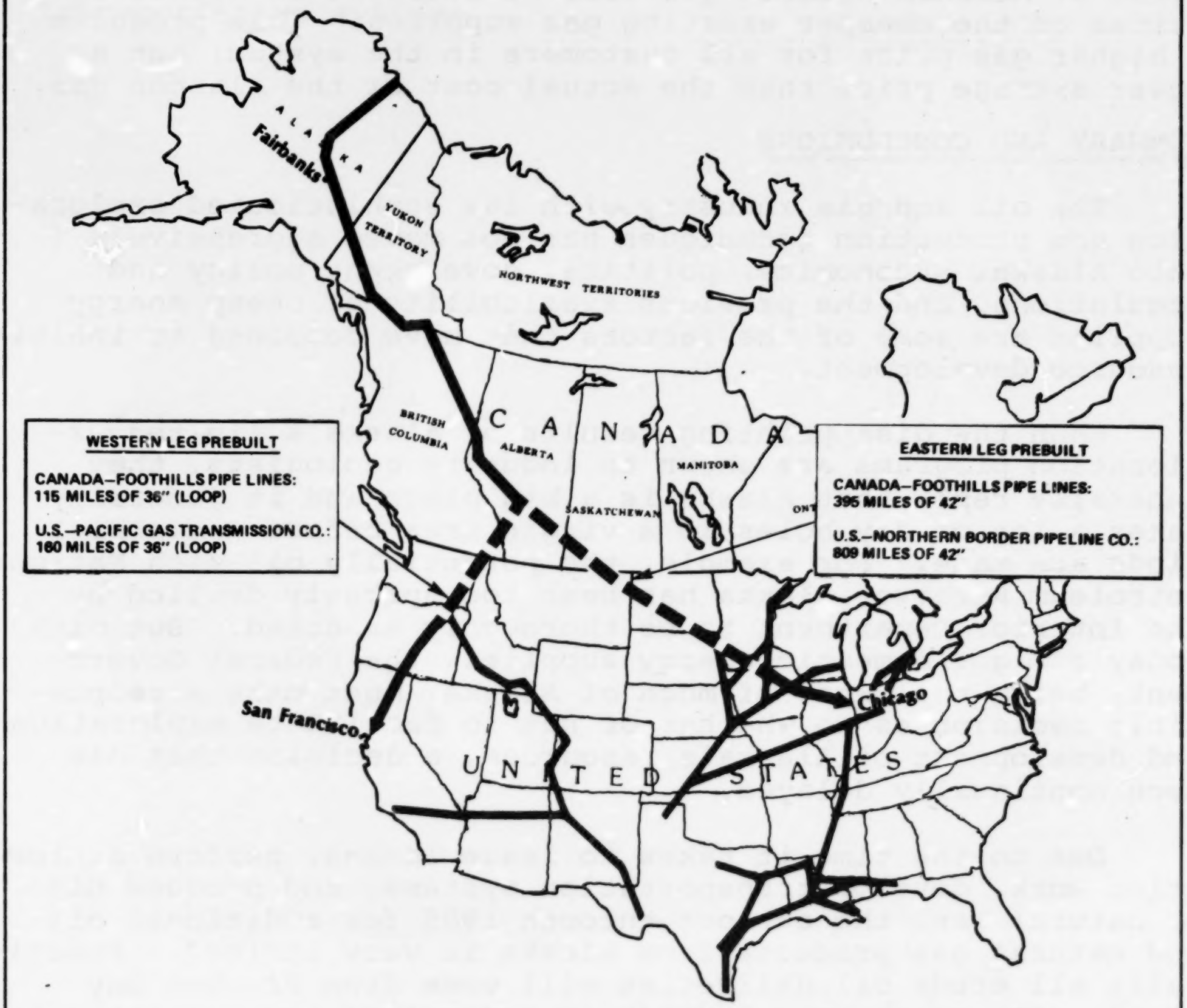
The Alaska Highway Pipeline Project will be the largest and most challenging natural gas pipeline project ever undertaken in North America. By late 1985 the 4,800-mile pipeline is expected to bring gas from Alaska's Prudhoe Bay to the "lower 48" at the rate of 2.4 Bcf per day, an amount equivalent to about 5 percent of current domestic consumption.

The total estimated cost of the pipeline system is $23 billion. The pipeline will cost $15 billion, and $8 billion more is needed for a gas conditioning plant and field costs at Prudhoe Bay. As of June 19, 1980, the sponsors still expect the project to be completed by late 1985.

Price of natural gas from Alaska

With the production of natural gas from Alaska still several years away, the price of the delivered product cannot be determined at this time. Gas industry officials estimate

FIGURE 2.8
ALASKA HIGHWAY PIPELINE PROJECT



Source: John G. McMillan, "Alaskan Natural Gas Transportation System Status and Outlook," statement before the subcommittee on Oversight and Special Investigations, Committee on Interior and Insular Affairs, October 15, 1979.

that Prudhoe Bay gas could cost $6 per Mcf by the time it reaches its market. However, "rolled-in" pricing of the Alaskan gas was allowed with the signing of the Natural Gas Policy Act in November 1978. Under rolled-in pricing, the price of Alaskan natural gas will be averaged in with the prices of the cheaper existing gas supplies. This produces a higher gas price for all customers in the system, but a lower average price than the actual cost of the Alaskan gas.

SUMMARY AND CONCLUSIONS

The oil and gas industry with its sophisticated exploration and production techniques has not moved aggressively into Alaska. Economics, politics, government policy and regulations, and the previous availability of cheap energy supplies are some of the factors that have combined to inhibit resource development.

When the disappointing results of Alaska's limited exploration programs are shown to industry geologists, they generally reply that Alaska is a big place and it generally takes a lot of dry holes in a virgin area before commercial finds are made. For example, the potentially oil-rich National Petroleum Reserve - Alaska has been too sparsely drilled by the Interior Department to be thoroughly assessed. But with today's tight domestic energy supplies, the Federal Government, being the owner of much of Alaska, must make a responsible decision as to whether or not to facilitate exploration and development of Alaska's resources, a decision that has been continually delayed.

Due to the time it takes to issue leases, perform exploration work, develop transportation systems, and produce oil or natural gas, the outlook through 1985 for additional oil and natural gas products from Alaska is very limited. Practically all crude oil deliveries will come from Prudhoe Bay at the rate of about 1.5 MMB/D (8 percent of the current U.S. daily usage). If the results of the December 1979 Beaufort Sea lease sale are upheld and oil is discovered, the additional oil would not be available until at least 1987, and some of this oil will only replace the decline in production from Prudhoe Bay.

While 26 Tcf of natural gas is available from Prudhoe Bay, a transportation system is needed to get this gas to market. The Alaska Highway Pipeline Project has many hurdles to clear before it comes on line and is not likely to be completed before late 1985. Current indications are that about 2.4 Bcf/d of gas (about 5 percent of current domestic consumption) will be coming through the line by that time, mostly

from Prudhoe Bay. Other areas of Alaska are also believed to contain recoverable natural gas deposits, but it will be years before they are developed. Thus the long-run supply outlook for natural gas through the Alaska pipeline appears promising, but is dependent upon building the proposed transportation systems.

CHAPTER 3

CANADIAN OIL EXPORTS TO THE UNITED STATES HAVE ENDED, BUT NATURAL GAS EXPORTS WILL CONTINUE

Canadian oil and gas do not now and will not in the future provide a significant part of total U.S. needs. However, certain areas of the United States are very dependent on Canadian oil and gas, and regional disruptions would occur if these imports ceased. Because the outlook for Canadian gas production is optimistic in coming years, exports to the United States at current or slightly increased levels are likely through 1990. Canadian oil exports, on the other hand, have ceased as of November 1979, except for small amounts of heavy oil that cannot be used internally and oil exchanged with the United States to solve transportation deficiencies in both countries.

Timely action by the United States on the Alaskan gas pipeline project could result in a short-term increase in Canadian gas exports. The Canadian government and gas industry generally support the project, but proposals to build the southern sections of the pipeline first and export Canadian gas through them will not be acted on until the Canadian government is sure that the entire project will be completed.

U.S.-CANADIAN ENERGY TRADE PICTURE HAS CHANGED

Energy trade levels and balance between the United States and Canada have varied over the years. Until 1959, Canada was a net energy importer from the United States, primarily through coal imports. Since that time, because of increased oil and natural gas exports, Canada has reversed the trade relationship. Its exports to the United States peaked in 1973 at 1.1 MMB/D and 2.8 Bcf a day of natural gas. Since then, however, Canada has followed a policy of cutting back oil exports in order to provide for current and future Canadian requirements. The same protection policy applies to natural gas, resulting in increased gas exports only after current and future Canadian needs are insured.

Canadian oil development--from imports to exports to export cutbacks

Canada was a large importer of crude oil until the discovery of the Leduc oil field in 1947 and the subsequent development of major production in western Canada. As pipeline facilities were extended to the east and west from

Edmonton, the Canadian producing industry supplied oil not only for domestic requirements but also for export to the United States. These exports peaked in 1973 at 1.1 MMB/D.

In the early 1970s, however, because of declining production, unsuccessful exploration, and OPEC actions, the Canadian government reconsidered its oil policy. The new policy is to increase the use of Canadian crude oil in Canada and phase out exports to the United States. As a result, Interprovincial Pipe Line's main line was extended to Montreal. The pipeline from the west to Montreal is currently running at or near capacity of 315,000 barrels per day. However, shipments are expected to drop back to about 250,000 barrels per day in 1981. Exports to the United States have been decreasing. From the peak of 1.1 MMB/D in 1973, the flow southward dropped to about 172,000 barrels a day in 1978.

Continually expanding Canadian gas development

Prior to 1957, Canada's reserves of natural gas had been building up at an unprecedented rate with no true market outlet other than limited local demand. Then, beginning in 1960, because of strong demand for natural gas in U.S. markets along with completion of the largest gas pipeline construction program in the country's history, the National Energy Board in Canada and the Federal Power Commission in the United States approved large-scale, long-term exports to the United States. Most of these contracts expire in the 1980s or early 1990s.

In 1970 Canada's National Energy Board (NEB) stated that there was insufficient surplus natural gas to meet any additional exports to the United States, and since then only small quantities of new gas exports have been approved on a short-term basis. However, since 1975, proved gas reserves in western Canada have increased significantly, and the November 1979 NEB report, "Reasons for Decision," on natural gas export applications, authorized additional exports of 3.75 Tcf to the United States over the next 8 years. 1/ Current authorized gas exports are about 1 Tcf per year, or 5 percent of U.S. gas consumption.

CONTINUED DECREASE IN CANADIAN OIL EXPORTS TO THE UNITED STATES

Significant oil exports from Canada to the United States are a thing of the past. Light oil exports ceased in November

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1/National Energy Board, "Reasons for Decision," Nov. 1979.

1979, except for very small amounts that, due to quality or geographical limitations, cannot be used in Canada, and this oil will continue to be priced at world levels. The impact of this on certain regions of the United States, while not as great as first believed, could become serious if a long-term solution is not reached to replace Canadian oil in the Northern Tier States.

Crude oil exchanges between the United States and Canada solve transportation deficiencies in certain areas of both countries. These exchanges, then, will continue until adequate oil transportation methods are developed for these areas.

Oil export curtailment pattern of recent years

In October 1974, the National Energy Board reported that Canadian supplies would be inadequate to serve traditional Canadian markets and expanded service into Montreal beyond 1982, and recommended that exports be phased out. (For more background on Canadian oil and U.S./Canada oil relations, see our report, "Prospects for Cooperation and Trade of Energy Resources between the United States and Canada," ID-80-2, Nov. 8, 1979.)

Commencing January 1, 1975, Canada instituted a protection procedure which resulted in a scaling down of its crude oil exports. On January 1, 1977, the National Energy Board modified its protection formula to stimulate heavy oil development. Heavy oil exports approximated 112,000 barrels a day during 1979, for total exports of about 155,000 barrels a day. In the future, heavy oil exports will be restricted only by actual productive capacity and Canadian demand.

Table 3.1 lists actual receipts of Canadian crude exports for 1971 through 1978 and the anticipated levels for 1979 through 1981.

Impact of Canadian oil curtailment on the United States

Serious shortages had been predicted for refiners in the Northern Tier States 1/ since the Canadian government announced that oil exports to the United States would gradually decrease and eventually cease. Since the initial reactions

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1/Montana, Minnesota, North Dakota, Wisconsin, Washington, Idaho, Illinois, Indiana, and Ohio.

TABLE 3.1

Canadian Exports to the United States, 1971-81
(Thousand barrels/day)

Year	Receipts
1971	775
1972	939
1973	1109
1974	878
1975	674
1976	437
1977	251
1978	172
1979	155
1980	80
1981	70
1982	65
1983	60
1984	50
1985	0

Note: Source for 1971-79 actual figures is DOE. Figures for 1980-85 are projected by DOE. However, these are only estimates and could be revised either upward or downward, depending on Canadian domestic demand.

to this policy, the predicted impact of the export curtailment has lessened. Many refiners using Canadian oil have access to oil through pipelines from the Midwest, Southwest, and Gulf Coast. As explained previously, heavy crude oil exports can continue as long as they cannot be used in Canada, which will probably not be before 1985. Exchanges of oil also are likely to continue at current levels given the convenience and cost savings of those arrangements for both countries compared to alternative transportation methods. Finally, in the short term nonpipeline transportation can be used by Northern Tier refiners to make up most of the deficits predicted for the early 1980s.

A long-term solution is necessary

All of these arrangements, however, are only stop-gap measures. Canada's goal of energy self-reliance will eventually cause decreases in heavy oil exports and exchanges, while nonpipeline transportation methods will become too expensive to continue for very long.

Therefore, a west-to-east pipeline system is necessary to provide a long-term solution to the Northern Tier's crude oil needs. DOE has done an indepth analysis of this option, and has stated that such a pipeline is in the national interest. 1/ Its report was prepared to assist the Department of the Interior in assessing four proposals to build pipelines to move crude oil from the U.S. or Canadian West Coast to the the U.S. Northern Tier.

Under section 507, title V, Public Utility Regulatory Policies Act of 1978, the President may grant expedited Federal permits to such pipeline proposals if he finds that they are in the national interest. In accordance with this act, the Secretary of the Interior has recommended that the President approve the Northern Tier Pipeline Company's proposed pipeline. This system would eventually carry up to 933,000 barrels of oil per day from Washington State to Clearbrook, Minnesota. Most of this oil would come by tanker from Alaska to Washington.

U.S./Canadian oil exchanges will probably continue

Prospects for continued oil exchanges at current levels appear good through the 1980s. As mentioned, these exchanges solve transportation deficiencies in both countries and will be continued unless cheaper transportation alternatives are developed. Significantly expanding these exchanges, however, would be difficult and is not likely.

Exchanges of crude oil between the United States and Canada currently account for about 188,000 barrels a day of supply to Northern Tier refiners. Given Canada's decision to curtail sales of crude oil to the United States, these exchanges have proved to be a significant factor in averting serious supply problems in the Northern Tier.

Currently there are two types of exchanges:

1. U.S. companies send oil from the Gulf Coast to Montreal through mid-continent pipelines, while Canadian companies send an equal amount of oil from Alberta to Northern Tier States through the Inter Provincial Pipe Line. About 155,500 barrels a day is exchanged this way.

1/See U.S. Department of Energy, Office of Policy and Evaluation, "Analysis of West-to-East Pipeline Application Under Title V Public Utilities Regulatory Policy Act," July 11, 1979.

2. U.S. companies send oil through a pipeline from Portland, Maine, to Montreal, and an equal amount goes to the Northern Tier States from Alberta through the Inter Provincial Pipe Line. About 32,500 barrels a day is exchanged this way.

These exchanges were developed in the absence of any formal international agreement. They are the product of mutual commercial interests and the longstanding tradition of U.S.-Canadian cooperation. Current oil exchange levels will be maintained as long as no other tansportation method is available for these areas of the United States and Canada.

Canada's crude oil pricing policy

Simply stated, Canada's oil export prices are pegged to world prices for similar quality oil. Periodic reviews of current prices are made and the export prices are adjusted accordingly. Currently these prices are about $38.42 per barrel for light crude and $36.50 per barrel for heavy crude.

CURRENT EXPORTS OF CANADIAN NATURAL GAS WILL CONTINUE AND POSSIBLY INCREASE

Changes in Canada's natural gas pricing policy have increased exploration, resulting in significant increases in proved and potential gas reserves. However, expansion of the natural gas market in Canada is limited, making exports of gas to the United States necessary to economic development of Canada's future gas resources.

Before proceeding further, the relative size of respective resources and markets has to be considered in evaluating the potential for additional gas exports. The United States has proved reserves of 200 Tcf and uses about 20 Tcf per year. In contrast Canada's proved reserves are about 72 Tcf; it uses 1.6 Tcf per year, and exports 1 Tcf per year to the United States.

These figures, combined with Canada's resource protection and energy self-reliance policies, will result in gas exports merely maintaining their current market position of providing about 1 Tcf of natural gas to the U.S. through 1990, then declining to less than one-half a Tcf by 2000. Any expectations of huge increases in gas exports from Canada are unrealistic.

Canadian gas reserves and resources outlook has improved significantly

The natural gas supply picture in Canada has changed dramatically in the past 5 years. As recently as 1975, the National Energy Board concluded that there were probably insufficient near-term gas supplies to fully cover the quantities licensed for export and the quantities required to meet increasing Canadian demand. Since then, however, price increases and attractive incentives for exploration and development have caused significant increases in natural gas reserves and ultimate potential for gas in Canada.

The National Energy Board has estimated established gas reserves in Canada at the end of 1979 to be 71.0 Tcf, an increase of 1.6 Tcf from their 1978 year-end estimate. The Board also estimates established reserves of 14.5 Tcf in the frontier areas (Mackenzie Delta and Arctic Islands), an increase of 1.9 Tcf from their 1977 year-end estimate. In addition, the Board's 1979 estimates of gas reserves additions to the year 2000 and of ultimate potential in Canada have increased to 46 Tcf and 162 Tcf, respectively, from its 1978 estimates of 38 Tcf and 147 Tcf.

While these increases are significant, industry officials in general believe that the National Energy Board is overly conservative, especially regarding gas reserves additions and ultimate recovery. Tables 3.2 and 3.3 compare various company and industry estimates of these items with the Board's estimates, and point out the Board's relative conservatism (note estimates for Alberta in particular). Also, the Deep Basin area in Alberta and British Columbia was considered separately by the Board and assigned established gas reserves of 1 Tcf. 1/ The gas industry in Canada almost universally agrees that currently recoverable reserves in the Deep Basin are at least 2 Tcf, while the main exploration company in the area estimates that at today's level of economics and technology 50 Tcf is recoverable, with ultimate recovery estimated at 440 Tcf.

The optimism on potential gas resources is shared by the Alberta Energy Resource Conservation Board. In a June 1979

1/ In general terms, this is the western part of the Western Canada Sedimentary Basin. The major exploration company in the area most specifically describes it as a 400-by-90-mile front in northwestern Alberta and northwestern British Columbia.

TABLE 3.2

Forecasts of Natural Gas Reserve Additions
In Conventional Producing Areas--1978-2000
(Tcf)

	Alberta	Western Canada total	Canada total
Alberta Energy Resource Conservation Board	23.6-33.4	-	-
Alberta Gas Trunk Line Co., Ltd.	58.8	70.4	-
Alberta And Southern Gas Co., Ltd.	46.4	-	-
Amoco Canada Petroleum Co., Ltd.	83.4	-	-
Canadian Petroleum Association	-	-	46.0-92.0
Dome Petroleum, Ltd.	-	-	69.3
Gulf Oil Canada, Ltd.	31.2	45.1	45.3
Home Oil Company, Ltd.	-	62.6	-
Imperial Oil, Ltd.	22.7	-	30.7
Independent Petroleum Association of Canada	-	-	58.0
Norcen Energy Resources, Ltd.	-	-	39.3-41.9
Pan Canadian Petroleum, Ltd.	45.1	-	52.5
Pro Gas, Ltd.	-	-	49.5
Shell Canada Resources, Ltd.	24.7	31.8	39.7
TransCanada Pipelines, Ltd.	29.6-46.8	40.8-58.0	41.0-58.2
National Energy Board	31.0	-	38.0

Source: National Energy Board, "Canadian Natural Gas Supply and Requirements," Feb. 1979.

report on Alberta gas reserve and removal matters, the Alberta Board estimates ultimate potential for gas in the province to be in the range of 130 to 140 Tcf. In addition, the Alberta Board stated that:

> "If gas prices go well beyond those currently anticipated by the Board and/or if substantial technological breakthroughs are achieved, particularly related to production of gas from tight formation, the ultimate potential could increase significantly and may well be in excess of 200 tcf."

Perhaps the most telling example of the reversal in gas reserves outlook is the National Energy Board's estimate of Canada's gas supply/demand balance. In its June 1977 Northern Pipelines Report, the Board concluded the deficiencies in meeting Canadian demand plus authorized exports would occur

TABLE 3.3

Ultimate Potential Estimates of Marketable Gas--
Conventional Producing Areas
(Tcf)

	Alberta	Western Canada total	Canada total
Alberta Energy Resource Conservation Board	130-140	-	-
Alberta Gas Trunkline Co., Ltd.	-	204	-
Alberta and Southern Gas Co., Ltd.	130	-	-
Amoco Canada Petroleum Co., Ltd.	204	-	-
Dome Petroleum, Ltd.	-	180	-
Gulf Oil Canada, Ltd.	105	138	143
Home Oil Co., Ltd.	-	170	-
Hudson Bay Oil and Gas Co., Ltd.	130	149	150
Imperial Oil, Ltd.	114	139	140
Independent Petroleum Association of Canada	-	180	-
Mobile Oil Canada, Ltd.	130	-	-
Pan Canadian Petroleum, Ltd.	195.1	231.9	-
TransCanada Pipeline, Ltd.	110-130	-	-
National Energy Board	125	146	147

Source: National Energy Board, "Canadian Natural Gas Supply and Requirements," Feb. 1979; and Alberta Energy Resource Conservation Board, "Summary Report on Alberta Gas Reserve and Removal Matters," June 1979.

in 1983. 1/ Now, the Board has stated the Canadian demand plus authorized exports can continue until 1992, and some industry estimators see no deficiencies until beyond 2000.

Expanding natural gas use in Canada will be difficult

Although several economic and political problems are involved in expanding markets for natural gas in eastern Canada, the benefits of displacing some imported oil in these markets and contributing to the goal of energy self-reliance will result in some expansion. The effect on export levels will

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1/National Energy Board, "Reasons for Decision--Northern Pipelines," June 1977.

not be significant, since the estimated gas demand in eastern Canada is relatively small. In fact, this gas market expansion would probably benefit gas exports, at least politically, since it would demonstrate the government's commitment to using indigenous resources as much as possible before allowing exports. Meeting gas demands in existing markets in Canada will not be a problem in the foreseeable future.

The major factors inhibiting the further expansion of the natural gas market into eastern Canada are

--the price of gas versus the prices of competing fuels, such as heavy fuel oil,

--the current and expected availability of heavy fuel oil, and

--the fact that the potential gas markets are small and widely spaced.

While high natural gas prices in Canada have increased exploration and discoveries of gas, the fixed price relationship of natural gas to crude oil has not allowed gas the price flexibility needed to penetrate new markets. Canadian government officials believe that any attempt to increase natural gas use in markets currently using residual fuel oils by reducing the gas price would be met by a price reduction for the residual fuel oil. The government could impose restrictions on residual oil supply in these markets, but this causes problems for refineries, who could have to further refine and upgrade it, reduce their operating levels, or export the residual fuel oil.

Despite these problems, some level of gas expansion in eastern Canada will occur. Most of the government and industry officials we spoke to believe that this is almost a prerequisite for allowing further gas exports to the United States, to show the government's commitment to energy self-reliance. A federal-Alberta task force has been formed to discuss ways of encouraging gas expansion schemes. In addition, the National Energy Board stated that the best way to dispose of residual fuel oil displaced by natural gas is for affected refiners to adapt their equipment and operations over a period of time to convert this heavy oil to lighter products.

Whatever solutions Canada finally adopts, the effect of gas expansion on exports to the United States will be negligible. The National Energy Board estimates additional gas

demand in the expanded markets at 182.3 Bcf per year in 1990. This is only about 6 percent of the Board's estimated total supply capability in 1990 from conventional producing areas, and this total capability does not include potential from frontier areas.

Finally, as appears obvious from discussions of gas expansion and exports, meeting demand in existing markets is not considered a problem in the foreseeable future. Total Canadian conventional supply is estimated by the Board to meet total Canadian demand plus authorized exports until a deficiency occurs in 1993. Most industry estimates put this date back to the late 1990s or beyond 2000, and again these estimates do not include potential supplies from the frontier areas.

Canada's current gas surplus and exports

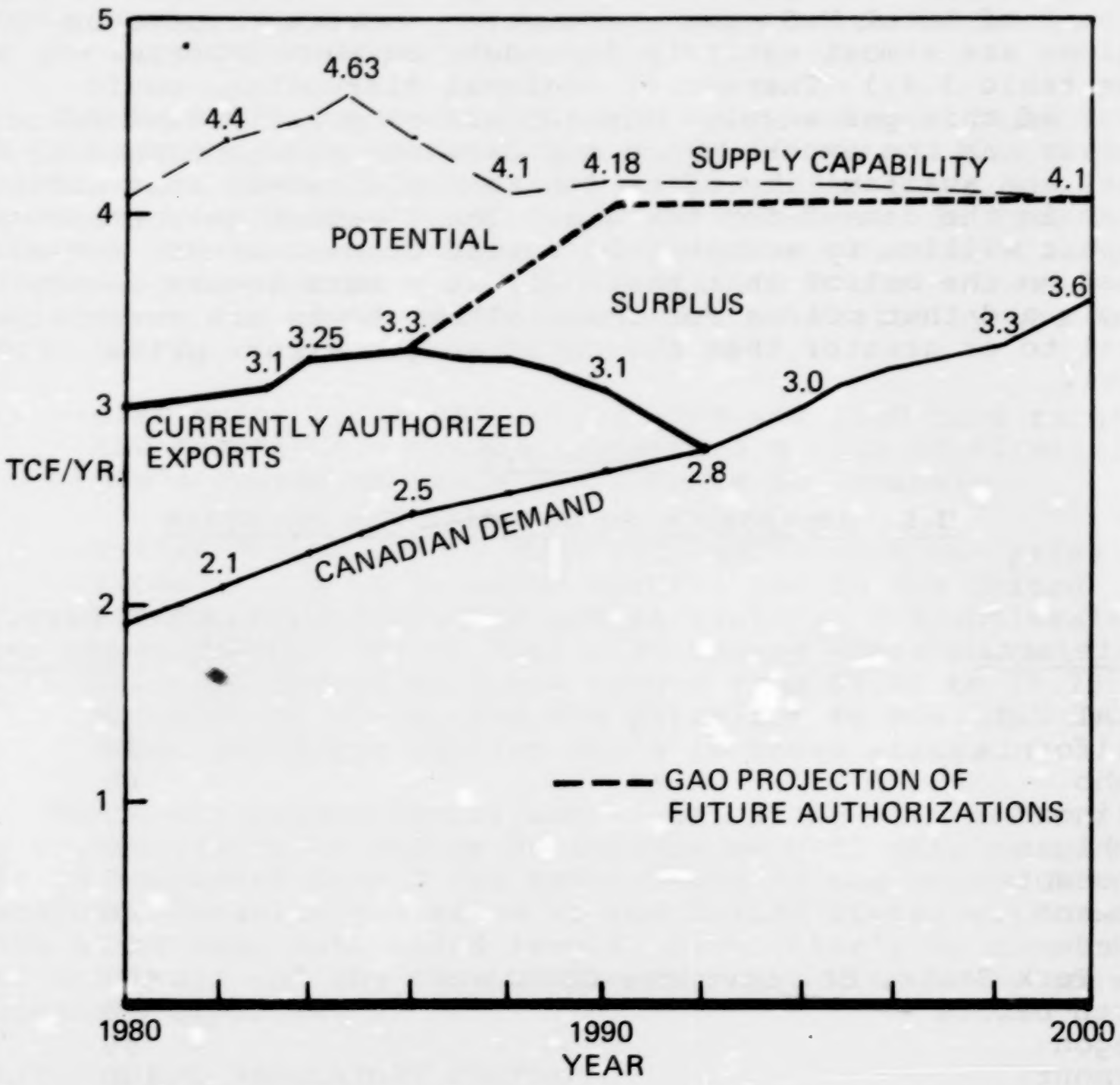
The National Energy Board has stated, based on its new procedures to determine surpluses, that a total of 3.75 Tcf of natural gas is currently surplus to Canadian needs and is available for export to the United States over the next 8 years. This current gas surplus is in addition to currently authorized exports totaling over 10 Tcf through 1995. Successful renegotiation of most existing contracts is likely, although they will be for shorter periods.

For over 20 years, the United States and Canada have participated in sales and/or exchanges of natural gas, with the level of imports peaking at 1,027 Bcf in 1973. In 1978, imports were 881 Bcf, or about 5 percent of U.S. gas consumption. The current status of U.S./Canadian sales contracts is shown in detail in figure 3.1, including estimates of remaining contracted reserves. It is interesting to note that these remaining contracted reserves represent about 15 percent of Canada's total established reserves estimated by the National Energy Board for year-end 1978.

Government and industry officials in both countries, based on the gas supply outlook in Canada, said that most existing contracts would probably be successfully renegotiated. However, because of increasing concern over adequate energy supplies for future Canadian needs, these contracts will be for shorter periods (7 to 8 years vs. up to 25 years). Figure 3.1 depicts the potential surplus Canadian gas through 2000, assuming continuation of the current reserves addition rate.

FIGURE 3.1

POTENTIAL SURPLUS
CANADIAN NATURAL GAS -- 1980 - 2000
(TCF/YR.)



Assumptions:

Demand--NEB forecast, based on an average annual growth rate of 2.9 percent to the year 2000, including expansion of gas markets in eastern Canada.

Supply capability--this estimate is based on continued reserves additions in the range experienced in Canada since 1976 (3-4TCFperyear). It is similar to estimates made by several gas companies and industry organizations in Canada during NEB natural gas supply hearings.

Canadian gas price increases will not significantly affect its marketability in the United States

While natural gas from Canada provides only about 5 percent of total U.S. gas consumption, several States or regions are almost entirely dependent on such imports. (See table 3.4.) Therefore, regional disruptions could occur if this gas supply were cut off or greatly diminished. However, as the export price for Canadian gas continued to rise, the availability of alternate fuels caused some softening in the demand for the gas. The Canadian government appears willing to accept this threat from alternate fuels, based on the belief that their gas is a more secure energy supply and that prices for these alternatives are currently equal to or greater than the Canadian gas export price level.

TABLE 3.4

U.S. Dependency on Canadian Gas by State

State/area	Estimated percent Canadian gas used
Total U.S.	5
California	24
Idaho	66
Illinois	5
Michigan	9
Minnesota	5
Montana	46
Nevada	40
New York State, St. Lawrence County	100
North Dakota	19
Oregon	65
Vermont	100
Washington	65
Wisconsin	15
Wyoming	27

Total deliveries of Canadian natural gas to the United States in 1978 were some 110 Bcf less than deliveries in 1977, with nearly all of the shortfall occurring in the California and Pacific Northwest markets. Canadian gas had to compete

in this area with a surplus of residual fuel oil, arising partly from imports of low-priced offshore product and partly from the availability of Alaskan North Slope crude with its characteristically high heavy-fuel-oil yield. This fuel oil surplus gave rise to a disruption in the natural gas market, especially in the industrial sector. As a result, the National Energy Board did not recommend any price increases for gas exports during 1978.

During 1979, however, the Canadian government raised the gas export price three times--to $2.30 per million British thermal units (Btu's) in May; to $2.80/million Btu's in August, and to $3.45/million Btu's in November. In January 1980, the NEB recommended, and the Canadian government adopted, a further price increase to $4.47/ million Btu's. There are two main reasons for these price increases, as stated by the National Energy Board.

--OPEC price increases during 1979 and 1980 have raised the substitution value of natural gas to $4.47/million Btu's (based on crude oil imports to Canada).

--Prices for #2 and #6 fuel oil, considered the prime alternatives to Canadian natural gas in the United States, have increased substantially. The wholesale posted price for #2 fuel oil in many areas where Canadian gas is sold has ranged from $5.25 to $5.75 per million Btu's, and the price for #6 fuel oil is about $4.00/per million Btu's in these areas.

These oil product price increases, along with efforts in the United States to reduce dependence on OPEC oil, could result in increased demand for natural gas in the United States. Therefore, Canadian gas sales in the United States will continue at or near authorized levels, particularly by companies that can "roll in" the cost of Canadian gas with lower cost indigenous supplies.

POLITICAL AND REGULATORY FACTORS AFFECTING CANADIAN GAS AND OIL EXPORTS

Canada's government has stated that Canada will be energy self-sufficient by 1990. To achieve this, all energy resources in Canada will be carefully analyzed and efforts will be made to use as much of their resources as possible internally before exports to the United States are allowed. For the United States, this means that oil imports from Canada

in significant quantities are a thing of the past, and natural gas imports, notwithstanding optimism on potential gas resources in Canada, will remain the same or only slightly increase from current levels.

Canadian provincial and Federal regulatory officials we met with appear well informed on the status of the oil and gas industry in Canada, and the regulatory process for export applications seems to satisfy most participants as far as processing time and thoroughness are concerned. According to a member of the Alberta Energy Resources Conservation Board, however, delays can occur because regulatory decisions on oil and gas exports are subject to further review and approval by both provincial and federal energy officials.

Oil and gas pricing policy has been revised to incrementally raise oil and gas prices to world levels. This includes oil and gas export prices, which are tied to the price Canada pays for imported oil and will continue to increase as Canada's costs increase.

Canada's policy for attaining self-reliance in gas and oil

In April 1976, the Canadian government adopted a strategy to prepare Canada for the energy problems of the future. The objective of this strategy is energy self-reliance, and the government's nine major policy elements to achieve this are

--appropriate energy pricing,

--energy conservation,

--increased exploration and development,

--increased resource information,

--substituting domestic energy for expensive imported energy,

--new or improved transportation and transmission systems,

--emergency preparedness,

--increased research and development, and

--greater Canadian content and participation.

In practical terms, this strategy entails reducing vulnerability to arbitrary price changes or prolonged supply interruptions for imported oil. It means that oil import dependence will be reduced to no more than one-third of total oil demand by 1985 and that natural gas will be preserved for domestic use until frontier resources can be brought on line, and near, if not full, commodity pricing for gas sold in Canada within 2 to 4 years.

The implications of Canada's energy policy for oil and gas exports, then, becomes clear. Oil exports, except for some heavy oil that cannot be used internally, have ceased. Natural gas exports will most likely continue at current levels and perhaps slightly increase through the 1980s, but will then start decreasing as more gas is used internally.

Canadian oil and gas export regulatory process

Overlapping jurisdiction and political involvement complicate the Canadian regulatory process for approving oil and gas exports. A member of the Alberta Energy Resources Board described the export application review process as follows:

1. A removal permit must be obtained from the energy board in the producing province.

2. The provincial government must approve the removal permit.

3. An export license must be obtained from the National Energy Board.

4. The federal government must approve the export license.

The export application can be effectively rejected at any one of these four steps.

ALASKAN GAS PIPELINE PROJECT-- CANADIAN ISSUES

Organizational, political, regulatory, and financial problems with the Alaska Highway Pipeline Project (see p. 22) are less complicated in Canada than in the United States. Construction of the Canadian sections of the transportation system have been approved, based on assurances by the U.S. Government that the entire project will be completed. Industry and government in Canada are waiting for the American pipeline

sponsors and the U.S. Government to resolve the financing impasse in this country.

Notwithstanding the U.S. domestic issues that will ultimately determine the fate of the pipeline, a number of important and explicitly Canadian questions affect the prospects for financing and building the entire system.

Canadian legal, political, and private sector involvement is less cumbersome than in the United States

According to a report prepared for the Alaska legislature, three key differences between the United States and Canada encourage optimism for solving the problems facing the Alaskan gas pipeline in Canada. 1/

First, while legal challenges routinely confront the U.S. Federal Energy Regulatory Commission's decisions, Canada's National Energy Board has rarely been taken to court. Moreover, Canada's courts appear less inclined to second-guess official policy or administrative decisions.

Second, even with the same party in control of the Presidency and both houses of the U.S. Congress, agreement on any course of action is by no means automatic. However, the Canadian parliamentary system of government insures that the ruling party in the House of Commons will not seriously question a course of action chosen by the Prime Minister and his Cabinet.

Third, the industrial climate in Canada offers greater potential for negotiating and compromising among private interests. While Canada does have antitrust statutes modeled on U.S. law, in practice they do not seem to have the same limiting effect on cooperation among private entities. The Alaskan gas pipeline's Canadian sponsors are an example of this. The corporate groups currently or potentially involved are intimately connected through various joint ventures and subsidiary ownership.

In all, governmental action in Canada is far less threatened by court challenges; Canada's political organization brings the policies of Parliament, the Prime Minister, and the National Energy Board into accord with one another; and Canada's private sector can more easily resolve its own conflicts than industry in the United States.

1/Tussing and Barlow, "Financing the Alaska Highway Gas Pipeline--What Is To Be Done?," Institute of Social and Economic Research, University of Alaska, Juneau, Alaska, Apr. 1979, pp. 70-71.

Problems with building the Canadian section of the pipeline

Despite the advantages stated above, several problems threaten the building of the Alaskan gas pipeline in Canada. To a large extent, solving these problems depends on specific actions of the U.S. Government.

Canada's main interest in the Alaskan gas pipeline is the role its construction will play in boosting the Canadian economy, rather than its possible use as a delivery system for Canadian Arctic gas. This is why Canadian officials emphasize "Canadian content" (the proportion of Canadian labor and materials used in the Canadian segments) in discussions with U.S. officials. Many Canadians see no urgency in building the Dempster lateral pipeline to connect Canadian Arctic gas to the Alaskan gas pipeline. The National Energy Board has stated that this gas will not be needed until 1992, or later, and by that time sufficient reserves could be found in this area to justify a separate transportation system. Therefore, if the United States tries to impose its own priorities on Canada regarding procurement policies for building the pipeline, timely completion of the Canadian segments would be seriously jeopardized.

Also, despite the benefits pipeline construction would bring to the Canadian economy, the Canadian government cannot be expected to take on any sizeable risk for the Alaskan gas pipeline project. The pipeline is overwhelmingly viewed by the Canadian public as a U.S. project to provide U.S. consumers with U.S. gas. Therefore, public and political pressure most likely will preclude significant financial involvement by the Canadian government.

In summary, industry and government in Canada are waiting for the American pipeline sponsors and the U.S. Government to resolve the financing in this country. Once this is done, most of the problems related to building and financing the Canadian segments of the systems will be easier to solve.

CONCLUSIONS

Canada is committed to energy self-reliance. To achieve this goal, every effort will be made to use or reserve oil and gas internally in the future, before exports are even considered. Any oil or gas exports from Canada, then, will be approved for short periods and priced at world levels. The size of any exports will not, in an overall sense, be significant to U.S. needs.

Oil exports will continue to be phased out, and after 1981 the United States is expected to receive relatively small amounts of oil through exchanges and short-term limitations on the use of heavy oil in Canada. These exports will be important to the Northern Tier States, but even these will be reduced starting in the mid-1980s when Canada will be able to use this oil internally. A west-to-east pipeline system must be in place when this occurs if Northern Tier refiners are to replace Canadian oil with Alaskan oil.

Notwithstanding the optimism and potential for Canadian natural gas resources, exports to the United States are not likely to increase significantly. The National Energy Board, because of constant pressure to save Canada's resources for Canadian use, will proceed cautiously on approving new export licenses; existing contracts will probably be successfully renegotiated, but for a shorter period (7 to 8 years vs. up to 25 years). Therefore, Canadian gas exports are expected to maintain their current market positions in the United States through the 1980s (about 5 percent of U.S. consumption). After 1990, exports will begin to decrease as more gas is needed in Canada.

The Canadian government has approved pre-building of the southern legs of the Alaska Highway Gas Pipeline System, and completion of the entire project has been assured. Timely action on the financing of the project in the United States could result in gas export increases over the next several years while the Alaskan segment of the pipeline is being built.

CHAPTER 4

MEXICAN OIL AND GAS RESERVES COULD PARTIALLY COMPENSATE FOR DECLINING DOMESTIC U.S. ENERGY SUPPLIES

Supplemental oil and gas supplies from Mexico, abundant as they could potentially be, will not be the solution to U.S. energy problems. They could, however, partly compensate for declining domestic production and help moderate U.S. dependence on OPEC oil. Mexico's resource availability is not in question. It has proved oil and natural gas resources and promising potential for future discoveries which could support booming production, including exports, through the next decade and beyond. The uncertain factor is the energy export policy Mexico will choose, based on political, socioeconomic, and technological considerations.

The Mexican government has so far indicated its preference for conservative rates of oil and gas production in the interest of developing all segments of its economy and providing employment without causing rampant inflation. It intends to satisfy its domestic energy demand first, and then export the available surplus.

This will mean fairly large exports in the 1980s. Oil production will outpace domestic demand, and the United States will probably be a prime user of the surplus in the coming decade despite Mexican attempts to diversify its trade relationships. Likewise, expanding associated gas production will exceed Mexico's domestic needs. Natural gas exports to the United States have already started.

MEXICAN OIL AND GAS RESERVES APPEAR IMMENSE

Over the past several years Petroleos Mexicanos (PEMEX), the government-owned company, has repeatedly announced significant additions to its estimated hydrocarbon reserves. Moreover, since all of Mexico's potential oil-bearing areas have not been explored, petroleum experts anticipate continued increases. As a result, Mexico's reserves have become the focus of world attention and speculation.

Assessments differ on Mexico's resource potential and the reliability of PEMEX's occasional pronouncements about oil reserves, but regardless of which set of figures one advocates, the country's energy abundance is impressive. Assuming even the most conservative viewpoint of potential hydrocarbon

reserves, Mexico has the resources to become a major petroleum producer and exporter.

PEMEX's reserve estimates have increased

PEMEX's estimates of proved oil and gas reserves have grown by an average of 89 percent annually, since January 1975. Table 4.1 highlights the dramatic increase on December 31, 1978, when proved reserves jumped to 26.93 BBO, and 66.32 Tcf of natural gas. Although somewhat the result of concentrated exploration and development, this growth primarily resulted from PEMEX's adoption of a less rigid definition of proved reserves, one that is more standard in the oil industry. PEMEX had not previously considered oil and gas reserves proved unless they were on line and ready to be produced, but began in December 1978 to include reserves which had been proved to a high degree of certainty but were not necessarily on line.

Unlike most petroleum-producing countries, Mexico combines its oil and gas reserves and reports the total in terms of barrels of oil equivalent. This practice could be misleading, creating the appearance of higher oil reserves than actually exist. PEMEX provides an annual breakdown of its reported reserves into crude oil, condensate, associated natural gas, and unassociated natural gas. Over the last few years, the ratio of liquids (crude oil and condensate) to gas (associated and nonassociated) has been approximately 2 to 1. Based on this fact, we assume throughout this report that 67 percent of the announced hydrocarbon reserve is oil and 33 percent is natural gas, although many sources round this ratio to 65:35.

Mexico's proved oil and gas reserves have elevated it to an important position in the world energy picture. At the close of 1978, Mexico was the fifth largest country in terms of proved oil reserves and sixth in natural gas reserves, holding about 4.4 and 2.6 percent of the world supply of the two hydrocarbons, respectively. These percentages are not as modest as they appear. In 1978, U.S. petroleum reserves supported the world's second highest production rate (8.7 MMB/D) with proved reserves that are about 0.4 BBO less than those of Mexico. Even more important, Mexico's reserve estimates resulted from limited exploratory drilling. As explained by a USGS senior scientist who conducted a study of Mexico's oil and gas potential, the important factor to note is not how much has been discovered already but the success of the exploratory drilling still being done. This drilling indicates that the potential for continued reserve additions is very favorable.

TABLE 4.1

Chronology of PEMEX Reserve Announcements (note a)

Date	Proved			Probable			Potential		
	Oil (BBO)	Gas (Tcf)	Percent Increase (decrease)	Oil (BBO)	Gas (Tcf)	Percent Increase (decrease)	Oil (BBO)	Gas (Tcf)	Percent Increase (decrease)
1938	0.831	2.045	-	-	-	-	-	-	-
1952	1.340	3.300	61%	-	-	-	-	-	-
1962	3.350	8.250	150%	-	-	-	-	-	-
Dec. 31, 1974	2.278	5.610	(32%)	-	-	-	-	-	-
Dec. 31, 1975	4.246	10.460	86%	-	-	-	-	-	-
June 30, 1976	-	-	-	-	-	-	80.400	198.000	-
Dec. 31, 1976	7.477	18.415	76%	-	-	-	-	-	-
Dec. 31, 1977	10.720	26.400	43%	20.770	51.150	-	80.400	198.000	0%
Sept. 1, 1978	13.400	33.000	25%	24.790	61.050	19%	134.000	330.000	67%
Dec. 31, 1978	26.930	66.320	101%	29.890	73.610	21%	134.000	330.000	0%

a/These oil and gas figures equate to PEMEX's reserve announcements in billion barrels of oil equivalents (BBOE). For example, PEMEX's December 31, 1978, proved reserve estimate of 40.19 BBOE consists of 26.930 Tcf of gas.

Resource estimates are diverse

Estimates of Mexico's proved oil and gas resources do not differ as drastically as do estimates of its potential reserves. The specific quantities of hydrocarbon reserves classified as proved and probable are the result of considerable analysis, evaluation, and testing by PEMEX. Estimates of potential reserves, however, are based largely on geological data indicating the best locations for drilling exploratory wells and are therefore speculative.

Mexico's proved reserves estimated at from 20 to 50 BBOE

Estimates of the proved and probable reserves of Mexico vary from a low of 20 to 40 BBOE to a high of 45 to 60 BBOE. Some experts do not even quote figures, speaking instead in terms of either a conservative or optimistic attitude on the part of PEMEX.

One source of data, a leading mineral evaluation firm under contract to PEMEX to verify the accuracy of its reserve estimates, agrees with PEMEX's latest estimate of reserves--40.2 BBOE proved, 44.6 probable, and 200 potentially ultimately recoverable. An official of the firm remarked that pessimistic reports of Mexican reserves are due to a lack of data.

Another Government agency, USGS, has a slightly more conservative view. It estimates proved reserves at between 20 and 40 BBOE. This estimate is based on PEMEX reserve announcements of August and December, 1978. If proved reserves were as PEMEX reports (40.2 BBOE), USGS would expect larger single accumulations of oil, or at least more than one field the size of the Bermudez field (2.7 BBOE of proved reserves). A USGS geologist noted that in most areas of the world where oil is discovered, the larger fields are explored and developed first, and he sees no reasons for Mexico to be any different.

On the other hand, some Government observers believe the reverse about Mexico's reserves. For example, according to the former Director of the State Department's Office of Mexican Affairs, the proved and probable reserve figures supplied by PEMEX may be understated.

Mexico's potential hydrocarbon reserves could be as high as several hundred BBOE

Wider disagreement exists with respect to potential reserves in Mexico. For example, one analysis by a USGS geologist applies the volumetric yield of three standard kinds of structural basins to the Mexican situation, and arrives at an estimate of Mexico's potential oil and gas reserves of between 75 and 186 BBOE, 35 to 146 billion barrels of which could be classified as undiscovered and recoverable.

Another analysis by a USGS geophyicist estimates potential reserves in the Reforma-Campeche trend by extrapolating from the potential of the already drilled portion of it, which is geologically similar. This analysis projects potential reserves at between 150 and 500 BBOE. 1/

This disparity highlights the speculative nature of any attempt to estimate the amount of potential oil and gas reserves in Mexico when only a small fraction of the oil-bearing area has been adequately explored. As stated by a USGS official, the extent of Mexico's potential reserves cannot be determined yet, and probably will not be known for at least another 5 years. However, based on geological data collected to date, the potential for future discoveries of large amounts of oil and gas south of the U.S. border looks very promising.

OIL PRODUCTION AND EXPORT POLICY EXPECTED TO BE CONSERVATIVE

Although experts disagree about the exact amount of petroleum Mexico has, most of them recognize it as a world leader in reserve holdings. Two areas of continuing speculation, however, are (1) How much oil will Mexico produce and when? and (2) How much Mexican oil will be available to the United States, when, and at what price?

As the size of Mexican reserves became known, optimists predicted the end of the world shortage and of U.S. dependence on the oil cartel. This op imism was dimmed, however, by President Portillo's announcement that despite the doubling of estimated proved reserves, his country will not increase production beyond its ability to "digest" the resulting income. Thus, realistic predictions of Mexican production and exports cannot be based on reserves alone. They must

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1/Not official USGS figures.

consider economic, political, social, and technological factors as well.

As discussed below, although Mexico will probably follow a conservative production policy, its oil will become an increasing share of U.S. consumption and imports. This could prevent further dependence on OPEC as well as partly compensate for declining U.S. production.

Reserves are not a production constraint

An analysis of Mexican reserves and maximum efficient production rates demonstrates that reserves could support production levels greater than those included in Mexico's oil and gas development plan. However, if more than 10 percent of the petroleum reserve is removed in a single year, i.e., a 10-to-1 reserves-to-production ratio, the total amount of petroleum that can eventually be recovered is reduced. For countries such as Mexico where proved reserves include fields that are still being developed, a proved-reserves-to-production ratio of 15 to 1 is more feasible. Applying this ratio to PEMEX's latest official proved reserve estimate of 26.93 BBO, Mexico could produce 1.8 BBO per year from proved reserves without compromising total production. This compares to actual Mexican production totaling 1.5 BBO in 1978 and planned production of .8 BBO in 1980, indicating considerable expansion capacity. Even if a more conservative estimate of proved reserves is assumed, substantial expansion capacity exists. For example, if proved reserves are only two-thirds of the official estimate, or 17.95 BBO, feasible and efficient production of 1.2 BBO per year would allow production to more than double from 1978 levels.

Steady production increases expected through decade

Those who are looking towards Mexico as the solution to our energy problems will be disappointed by most estimates of future production. According to PEMEX's original 6-year plan (1976-1982), production would increase from 1.1 MMB/D in 1977 to 2.2 MMB/D by 1982, but this schedule was revised to reflect the 1982 target being met by 1980. The Mexican government has stated that after 1980 oil production would not be increased beyond Mexico's capacity to use the oil export revenues. Therefore, production levels beyond 1980 are uncertain. Under Mexican law, no president may serve more than one term in office or commit his successor to his policies. Therefore, estimates beyond the near term are highly speculative and depend upon the assumptions made regarding future political and economic developments.

In its study on Mexican oil and gas, 1/ the Congressional Research Service (CRS) developed two scenarios of the Mexican oil and gas situation, based on different estimates of production, consumption, and exportable surpluses. One of these scenarios assumes associated gas will be exported to the United States, and the other assumes no gas exports. As will be discussed later, we do not believe associated gas will constrain oil production because Mexico will have several options for the use of its gas. Therefore, we consider here only CRS's estimates based on gas exports because these figures show higher production unconstrained by associated gas. CRS predicts Mexico's oil production will increase steadily from 1.8 MMB/D in 1979 to 3.8 MMB/D by 1988.

Estimates of future Mexican oil production can be placed in perspective by comparing them with the current output of the world's major producing countries. Table 4.2 shows that in 1978 Mexico accounted for only 2.0 percent of total world crude oil production. Assuming output of the other producing countries remains constant, projected 1985 Mexican production of 3.1 to 3.5 MMB/D would represent 5.0 to 5.6 percent of world production and would make Mexico the fifth largest oil-producing country.

Economic and political factors will constrain production

The importance of economic factors in determining Mexico's petroleum policies cannot be overemphasized. The current administration has made it clear that the pace of oil development will be determined by the ability to use oil revenues to develop all segments of the economy, not just the capital-intensive petroleum industry. The director general of PEMEX stated:

> "Technically, any petroleum engineer can tell you that with the reserves we have it's possible to produce more but it has a political angle. It is not the production of oil but the disposition of the wealth extracted from the ground. It should be channeled back to the country in order to avoid a crisis in the economy of Mexico, and we will produce as much as we can digest. The more we

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1/Congressional Research Service, "Mexico's Oil and Gas Policy: An Analysis," Joint Committee Print, Prepared for the Committee on Foreign Relations, U.S. Senate and the Joint Economic Committee, June 30, 1978.

TABLE 4.2

1978 World Crude Oil Production (note a)

Country	(MMB/D)	Percent
Saudi Arabia	8.3	13.8
Iran (note b)	5.2	8.7
Iraq	2.5	4.2
Venezuela	2.2	3.7
Kuwait	2.1	3.5
Libya	2.0	3.3
Nigeria	1.9	3.2
United Arab Emirates	1.8	3.0
Indonesia	1.6	2.7
Algeria	1.1	1.8
Other OPEC (Qatar, Gabon, Ecuador)	.9	1.5
Total OPEC	29.6	49.4
United States	8.7	14.5
Mexico	1.2	2.0
Others	6.8	11.4
Total non-OPEC	16.7	27.9
U.S.S.R.	11.2	18.7
China	2.0	3.3
Other communist	.4	0.7
Total communist	13.6	22.7
Total world	59.9	100.0

a/Based on data from "International Energy Statistical Review," National Foreign Assessment Center, CIA, June 27, 1979.

b/Iranian production dropped after the revolution. Apr. 1979 Iranian production was 3.6 MMB/D.

industrialize the country, the more we will require * * * funds, resources; the more we change the infrastructure, the more we have a better country, * * * the more we will need resources, and the more we will produce oil." 1/

Thus, the Mexican government's goal is to achieve a delicate balance between rapid resource development to get badly needed oil revenues, and slower, more controlled growth to minimize inflation and put these revenues to work where they can benefit the most people. It is difficult to translate this goal into barrels of oil.

Whereas economic considerations are the major influence on Mexican production policy, there is also a political factor. For nationalistic reasons, leftist and other factions object to the sale of Mexico's patrimony to foreigners, especially to Americans. Although a relatively small group, at times the leftists have been a vocal minority, such as during demonstrations against the sale of Mexican oil and gas prior to President Carter's February 1979 visit. Politics will be a large part of the Mexican government's attempted "delicate balance." 2/

Surplus oil will be sufficient to make Mexico a major exporting country

Although Mexico will not rival Saudi Arabia as the world's leading petroleum exporter, it will have sufficient quantities available to place it among the world's primary petroleum-exporting countries. Mexico's official energy policy is to satisfy its domestic needs first, then export any surplus production in order to build an economic development fund. Therefore, the volume of Mexico's petroleum exports will depend upon both production and internal consumption. As already discussed, Mexico will follow a slow, conservative production policy. Domestic oil consumption will be affected by the success of the government's program to convert domestic energy consumption from oil to natural gas.

1/Washington Star, "Q and A: What 'Saudis to South' Will Do With Oil," Interview with director-general of PEMEX, Feb. 12, 1979.

2/Additional background information and history from the Mexican perspective may be found in our report, "Prospects For A Stronger United States--Mexico Energy Relationship," ID-80-11, May 1, 1980.

Mexican oil consumption has more than doubled during the 1970s, reaching over 1 MMB/D in 1978. Increases in demand should continue throughout the 1980s because as petro-revenues are used to develop the economy, more energy demand will be created, particularly for oil and gas. The mix of oil and gas consumed will depend on the success of the oil-to-gas conversion program.

CRS prepared two sets of Mexican oil consumption estimates through 1988, one for each of its two scenarios (gas exports and no gas exports). The consumption estimates for the no-exports scenario are based on the assumption that Mexico will make a concerted effort to use its gas domestically by switching internal consumption from oil to gas, thus freeing oil for export. The second set of consumption estimates assumes that Mexican gas will be exported to the United States and a massive conversion will not be necessary. These two sets of estimates are shown as a range of domestic consumption in table 4.3. In addition, DOE's estimate of Mexican consumption noted in table 4.3 demonstrates that Mexican oil consumption will increase.

TABLE 4.3

Estimated Mexican Domestic Oil Consumption
(MMB/D)

Year	CRS	DOE
1979	1.0-1.1	-
1980	1.1	1.1
1981	1.1-1.2	-
1982	1.1-1.3	1.5
1983	1.2-1.4	-
1984	1.2-1.5	-
1985	1.2-1.5	1.5
1986	1.2-1.6	-
1987	1.3-1.7	-
1988	1.4-1.8	-
1990	-	2.0

Note: Table incomplete because the agencies did not estimate consumption for every year through 1990.

Estimates of surplus Mexican oil that will be available for export are shown in table 4.4. As was the case with production and domestic consumption, surplus oil available for export is expected to increase gradually over the next decade.

TABLE 4.4

Estimated Surplus Exportable Mexican Oil
(MMB/D)

Year	CRS (note a)	DOE (note a)
1979	0.7-0.8	-
1980	1.1	0.5
1981	1.1-1.2	-
1982	1.1-1.3	1.2
1983	1.2-1.4	-
1984	1.3-1.6	-
1985	1.6-1.9	2.0
1986	1.7-2.1	-
1987	1.9-2.3	-
1988	2.0-2.4	-
1990	-	3.0

a/Derived from table 4.3.

The United States will continue to receive a large percentage of Mexican exports

The remaining questions related to Mexican oil are: How much Mexican oil will be available for export to the United States, when will it be available, and how much will it cost? While Mexico will follow a policy of diversifying its export markets, the United States will receive increased oil supplies from Mexico due to increased production, and Mexican oil could become a significant percentage of U.S. oil imports. Although Mexican oil will not be the solution to the United States' energy problems, it could slow U.S. dependence on OPEC and partly compensate for declining domestic production.

Almost 87 percent of Mexico's surplus crude oil was sold to the United States in 1978, with most of the remainder exported to Israel (5.8 percent), Spain (4.0 percent), Canada (0.6 percent), and Brazil (0.4 percent). The U.S. percentage is expected to diminish, however, because the Mexican government is determined to reduce its trade dependence on the United States by customer diversification. Mexico recently signed long-term contracts to supply oil to Canada, Sweden, Japan, France, and Spain, and contracts with other countries, such as possible sales to Brazil, Argentina, and Uruguay, are being discussed. Mexico eventually wants to reduce the U.S. share of its oil exports to about 60 percent, with about 20 percent each going to Europe and the Orient, and smaller amounts for neighboring Latin American countries.

According to PEMEX, by the end of 1979, 80 percent of Mexican crude oil exports will go to the United States, and by 1980 the U.S. share could be reduced to between 60 and 66 percent. However, because total Mexican crude oil exports will increase over the next few years, the United States will receive a larger quantity of Mexican oil.

Table 4.5 presents a range of estimates of Mexican crude oil exports that could be available to the United States, and illustrates how these quantities may increase over the next decade. The U.S. market shares used in the analysis assume that successful achievement of PEMEX's market diversification goal will reduce the U.S. export share to 60 percent by 1981. This is a logical assumption given Mexico's recent oil agreements and a world market eager to "sop up" excess supplies.

TABLE 4.5

Estimated Quantities of Mexican Oil Available to the United States

Year	Surplus exportable Mexican oil (MMB/D) (note a)	Percent to U.S. market (note b)	Available to the United States (MMB/D)
1980	0.5-1.1	66	0.33-0.73
1981	0.9-1.2	60	0.54-0.72
1982	1.1-1.3	60	0.66-0.78
1983	1.2-1.4	60	0.72-0.84
1984	1.3-1.6	60	0.78-0.96
1985	1.6-2.0	60	0.86-1.20
1986	1.7-2.1	60	1.02-1.26
1987	1.9-2.3	60	1.14-1.38
1988	2.0-2.4	60	1.20-1.44
1990	3.0	60	1.8

a/From table 4.4.

b/Our assumptions based on PEMEX goals.

These estimates, if compared with total U.S. crude oil consumption, show Mexican oil will become an increasing share of U.S. consumption over the next decade, rising from about 2.8 percent of consumption in 1979 to about 10 percent of consumption in 1990. (See table 4.6.)

TABLE 4.6

Potential Mexican Crude Oil Exports to the United States as Percentages of U.S. Consumption

Year	Total crude oil consumption (MMB/D) (note a)	Projected range of exports to the United States (MMB/D)	Export range of percentage of U.S. consumption
1979	b/14.5	b/ 0.4	b/ 2.8
1980	15.2	0.3-0.7	2.0-4.6
1981	15.4	0.5-0.7	3.2-4.5
1982	15.6	0.7-0.8	4.5-5.1
1983	15.8	0.7-0.8	4.4-5.1
1984	16.0	0.8-1.0	5.0-6.3
1985	16.2	0.9-1.2	5.5-7.4
1986	16.4	1.0-1.3	6.1-7.9
1987	16.6	1.1-1.4	6.6-8.4
1988	16.8	1.2-1.4	7.1-8.3
1990	17.3	1.8	10.4

a/Assumes 1.3 percent rate of growth for comparative purposes.

b/Actual per EIA Monthly Energy Review.

Mexican oil will become an even greater percentage of U.S. imports in the future. By 1990, Mexico could account for as much as 24 percent of U.S. oil imports, a larger percentage than was provided by any single country in 1979, including Saudi Arabia (16.2 percent; see table 4.7). For comparison purposes, other suppliers of crude oil to the United States in 1979 who provided 5 percent or more of total imports were Nigeria (12.8 percent), Venezuela (8.2 percent), Libya (7.9 percent), Algeria (7.5 percent), and Mexico (5.1 percent). Total imports from all OPEC countries represented 66.8 percent of U.S. imports in 1979. In the coming years, Mexico will become an important source of imported oil, possibly providing the opportunity for U.S. diversification of its oil suppliers away from OPEC, or at least stabilizing U.S. dependence on OPEC imports as domestic reserves decline.

TABLE 4.7

Mexican Crude Oil Exports to the United States as Percentages of U.S. Imports

Year	Total crude oil imports (MMB/D) (note a)	Projected range of exports to the United States (MMB/D)	Export range as percentage of U.S. imports
1979	6.4	0.4	6.3
1980	6.5	0.3-0.7	4.6-10.8
1981	6.6	0.5-0.7	7.6-10.6
1982	6.7	0.7-0.8	10.4-11.9
1983	6.8	0.7-0.8	10.3-11.8
1984	6.9	0.8-1.0	11.6-14.5
1985	7.0	0.9-1.2	12.8-17.1
1986	7.1	1.0-1.3	14.1-18.3
1987	7.3	1.1-1.4	15.1-19.2
1988	7.4	1.2-1.4	16.2-18.9
1990	7.6	1.8	23.7

a/Assumes 1.6-percent rate of growth for comparative purposes.

Although Mexico is not a member of OPEC, its oil export price is in the upper range of OPEC prices. However, due to Mexico's proximity to the United States, the landed price of Mexican oil in the United States is lower than that of OPEC oil, with the exception of Venezuela. The United States is also Mexico's most economic market because it can realize a higher profit from sales to the United States than it can from countries farther away. Effective January 1, 1980, Mexico raised its crude oil price to $32 per barrel. This compares to the OPEC countries' latest announced prices, which range between $27 and $35 per barrel.

In summary, Mexico will increase oil production gradually to avoid economic problems. This oil will be used to satisfy domestic needs first, and any surplus will be exported. Due to increased production, the United States will receive increasing quantities of Mexican oil over the next decade, even though Mexico will diversify its export markets. Mexico should become a major source of U.S. oil imports.

NATURAL GAS PRODUCTION LEVEL AND EXPORT POLICY ARE UNCERTAIN

The magnitude of Mexico's natural gas discoveries has been somewhat overshadowed by its vast petroleum deposits. One reason is that this resource is only economically marketable within Mexico or via overland pipeline to neighboring countries. The United States, therefore, is a natural market for Mexico's natural gas; however, the volume of gas available for export is expected to be small.

Few question the long-range natural gas resource base of Mexico. The controversy has been confined to the same key issues discussed in the preceding section on oil. These issues are (1) How much gas will Mexico produce and when? and (2) How much Mexican gas will be available to the United States, when, and at what price? Answers to these questions depend upon the course of future events, but independent estimates of gas production and export levels have been made on the basis of certain qualifying assumptions.

Reserves are not a production constraint

In terms of Mexico's resource base, proved gas reserves are sufficient to support higher production levels than those contained in Mexico's oil and gas development plan. Specifically, the analysis of Mexican oil reserves and maximum efficient production rates discussed in an earlier section demonstrated that PEMEX's latest proved reserve estimate of 26.93 BBO could support yearly production of 1.8 BBO. Assuming that approximately 1,200 cubic feet of gas is produced with each barrel of oil (1,200:1 gas-to-oil ratio), 1/ associated natural gas production would be 2.16 Tcf per year. This compares to 1978 gas production approximated by DOE at .767 Tcf per year, of which one-half was produced in association with oil; and .913 Tcf a year approximated by CRS, of which .621 Tcf was associated. This implies that based solely on current reserve figures, considerable expansion in natural gas production is feasible. Even if a more conservative estimate of proved oil reserves--and the associated natural gas--is assumed, considerable expansion capacity still exists. For example, as assumed earlier in the oil policy section, if proved reserves are conservatively viewed as being 17.95 BBO (two-thirds of the PEMEX figure), associated gas production could be as high as 1.44 Tcf per year.

1/Historically, Mexican fields have averaged a 1,200:1 gas-to-oil ratio; however, some new fields indicate gas-to-oil ratios of as much as 3,000:1, while some offshore fields are estimated at 250:1.

Gas production expected to rise with associated oil production

One of Mexico's objectives is to increase gas production from 2.2 Bcf per day to 4 Bcf per day by 1982. 1/ Based solely on resource availability this objective appears attainable; however, because so much of Mexico's natural gas is associated with its oil, the quantity of gas produced is directly dependent upon the level of oil produced. Thus, achieving the gas production objective involves addressing the factors that could constrain crude oil production. These potential oil production constraints (primarily economic and political) have already been discussed.

As indicated by table 4.8, CRS visualizes steadily increasing Mexican gas production through 1988. Although some of the yearly estimates may have become obsolete since the study's publication, the trend depicted should remain unchanged. This gradual increase can be attributed mainly to the related planned increase in oil production and the assumption that the gas-to-oil ratio will increase 100 cubic feet per barrel per year.

Domestic consumption depends on success of oil-to-gas conversion program

Natural gas demand in Mexico from 1975 to 1978 was between 1.4 and 1.7 Bcf per day. Expectations are that domestic demand should increase substantially because of Mexico's conversion program to substitute gas for the use of other sources of energy.

The program dates back to a series of events that began in 1976 when PEMEX announced plans to construct a 48-inch pipeline between the Reforma area (Cactus) and the border city of Reynosa. The pipeline eventually was to be tied into the existing network of U.S. transmission lines at McAllen, Texas. On August 3, 1977, a consortium of six U.S. gas pipeline companies 2/ signed a letter of intent with PEMEX to purchase

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1/Based on its 1976 development plan, Mexico's goal was 2.2 MMB/D and 4 Bcf per day of gas by 1982. Subsequently, the oil and gas production objectives were moved forward to 1980.

2/Tenneco, Inc., Texas Eastern Transmission Corp., El Paso Natural Gas Co., Southern Natural Gas Co., Florida Gas Transmission Co., and Transcontinental Gas Pipe Line Corp.

TABLE 4.8

CRS Mexican Natural Gas Production Projections

Year	Bcf per day	Tcf per day
1979	3.0	1.095
1980	3.4	1.241
1981	3.8	1.387
1982	4.2	1.533
1983	4.7	1.716
1984	5.3	1.934
1985	6.1	2.226
1986	6.7	2.446
1987	7.6	2.774
1988	8.4	3.066

Source: Congressional Research Service, "Mexico's Oil and Gas Policy: An Analysis," Dec. 1978.

as much as 2 Bcf per day at a price indexed to the cost of #2 heating oil in New York harbor. At that time the price was $2.60 per thousand cubic feet; the equivalent price today has risen to the high $4 to $5 per thousand cubic feet range. The U.S. Government opposed the price, and the letter of intent expired on December 31, 1977. Thereafter, PEMEX announced plans to convert utility boilers, petroleum refineries and petrochemical plants, pipeline systems, and other major industries from fuel oil, diesel fuel, and liquid petroleum gas to natural gas.

Implementing the program will result in increased domestic demand for natural gas. The magnitude of the increase, however, is unclear, making attempts to project domestic demand speculative. PEMEX estimates it will take 2 years before the results of the program are fully known. It appears almost certain that Mexico's implementation of its conversion program will allow displaced fuel oil to be exported.

The success of the program depends on Mexico's ability to convert industrial, commercial, and residential users from fuel oil to natural gas and develop an adequate gas transportation and distribution network. According to a PEMEX spokesman, all large industrial installations in Mexico have the capability to burn either oil or gas, implying no major problems in converting Mexico's industrial sector. However, because of small, local distribution systems and a lack of gas appliances, limited gas substitution in the residential and commercial sectors will occur. As a result, even though

overall conversion from oil to gas in Mexico appears promising, substitution will be heavily concentrated in the industrial regions. With respect to the gas transportation and distribution network, although the design of the pipeline was slightly altered due to the failure of the 1977 gas export deal, the modified line has progressed successfully. In March of 1979, the 685-mile, 48-inch-in-diameter line from Cactus to San Fernando was completed, and a 155-mile, 42-inch branch from San Fernando to the industrial city of Monterey, Mexico, is currently under construction. In addition, laterals to petrochemical complexes have been added off this main line.

Less surplus gas likely due to conversion program

In 1976, Mexico had decided to rely on an oil-based domestic growth program and to export surplus gas associated with its oil fields to the United States, but as a result of the U.S. refusal to accept Mexico's terms, Mexico reversed itself and is developing a gas-based economy. As a result, Mexico has recently indicated that it may not have any surplus gas to export because it could all be used internally. However, this will not be the case. According to a former Department of State official, Mexico will have surplus gas, although it does not know precisely how large this surplus will be. The surplus is substantiated by the fact that Mexico is currently flaring a sizeable portion of its associated gas and is shutting in most of its nonassociated gas production.

The estimates of future Mexican natural gas production we discussed must be reduced by anticipated losses due to flaring, reinjection, extraction, and processing to arrive at "net production available." "Net production available" must be further reduced by domestic consumption to derive surplus gas available for export.

Table 4.9 on page 64, which is based on CRS data, presents a range of amounts of Mexican natural gas available for export through 1988. The gas production and net-production-available figures presented in the table are from CRS's gas exports scenario. As previously discussed, we believe these estimates are more realistic than CRS's production estimates for its no-gas-exports scenario. However, because the Mexican oil-to-gas conversion program has just recently been initiated, it is not clear what the appropriate future domestic consumption estimates should be. Therefore, we used CRS's consumption estimates from its gas-exports scenario to create the upper limit of our range of surplus exportable gas, and its consumption figures from its no-gas-exports scenario for the lower range.

A comparison of both estimates indicates that the differences in exportable surplus figures are caused by dissimilar forecasts of future domestic demand in Mexico. In general, the projections of Mexican gas production are similar. The reason disagreement exists with respect to domestic demand is because the ultimate success of Mexico's oil-to-gas conversion program is not yet certain.

To put the various estimates of exportable Mexican gas in perspective, it is useful to compare them to total U.S. natural gas consumption. Mexican natural gas exports will probably represent a small percentage (2.2 to 6.7 percent by 1988) of total U.S. production and imports. (See table 4.10.) However, because U.S. domestic production is declining, the supplemental supply from Mexico, although marginal, could be useful in offsetting a portion of this decline.

Agreement has been reached on gas exports

Exports to the United States offer Mexico the most economic use for its excess gas. The United States stands to gain an additional supply of natural gas to partially offset the decline of U.S. stocks, and both countries would benefit if a satisfactory conclusion to the gas situation facilitates further bilateral discussions on energy-related matters.

In September 1979, the United States and Mexico agreed to a framework for Mexican natural gas to be exported to the United States, and in October, six U.S. natural gas pipeline companies, through a wholly owned subsidiary, negotiated a contract with PEMEX. Exports of natural gas began after the contract was approved by each country's government.

Mexico has agreed to export 300 million cubic feet of natural gas per day to the United States. The original price was $3.625 per million Btu's (1 Btu is equivalent to appoximately 1,000 cu. ft.) as of Jan. 1, 1980, to be adjusted quarterly by the same percentage as the change in world crude oil prices pursuant to a specific formula agreed upon by the contracting parties. In March 1980, however, PEMEX boosted the price to $4.47 to match the Canadian increase.

The agreement provides for gas trade as long as the United States needs it and Mexico has surplus gas. Either nation may terminate the arrangement upon 180 days' notice. Also, the two governments are to review the terms of this arrangement from time to time.

TABLE 4.9

Upper and Lower Limits of Mexican Natural Gas Export Projections

Year	Production (Bcf per day) (note a)	Net production available (Bcf per day) (note a)	Domestic demand (Bcf per day) (note a)	Available for export (Bcf per day) (note b)	Available for export (Tcf per year) (note b)
1979	3.0	2.6	b/1.8-2.3	0.8-0.3	.292-.110
1980	3.4	2.9	1.9-2.6	1.0-0.3	.365-.110
1981	3.8	3.3	2.0-2.8	1.3-0.5	.475-.183
1982	4.2	3.7	2.1-3.1	1.6-0.6	.584-.219
1983	4.7	4.0	2.2-3.5	1.8-0.5	.657-.183
1984	5.3	4.4	2.3-3.8	2.1-0.6	.767-.219
1985	6.1	5.2	2.5-4.4	2.7-0.8	.986-.292
1986	6.7	5.8	2.6-4.8	3.2-1.0	1.168-.365
1987	7.6	6.4	2.7-5.2	3.7-1.2	1.351-.438
1988	8.4	6.9	2.9-5.6	4.0-1.3	1.460-.475

a/From CRS's gas-export scenario. CRS's estimates for its gas exports scenario are the upper limit of GAO's range.

b/Our analysis based on CRS data.

TABLE 4.10

Projected Mexican Natural Gas Exports as a Percentage of U.S. Consumption

Year	Total natural gas production & imports (Tcf per year) (note a)	Projected export range (Tcf per year)	Export range as percentage of U.S. consumption (percent) (note b)
1979	20.3	0.1-0.3	0.5-1.4
1980	20.6	0.1-0.4	0.5-1.8
1981	20.6	0.2-0.5	0.9-2.3
1982	20.5	0.2-0.6	1.1-2.9
1983	20.8	0.2-0.7	0.9-3.2
1984	21.1	0.2-0.8	1.0-3.6
1985	20.9	0.3-1.0	1.4-4.7
1986	21.3	0.4-1.2	1.7-5.5
1987	21.3	0.4-1.4	2.1-6.3
1988	21.7	0.5-1.5	2.2-6.7

a/Projections taken from estimates of U.S. natural gas production by region, Legislative Branch Support, Data Resources, Inc., Washington, D.C., Jan. 26, 1979.

b/Computational differences due to rounding.

The gas companies received the necessary approvals from the Economic Regulatory Administration (ERA) and the Federal Energy Regulatory Commission (FERC). ERA has the authority under section 3 of the Natural Gas Act and Executive Order 10485 to determine whether imports or exports of natural gas are consistent with the public interest. FERC has the authority under section 3 of the Natural Gas Act, except insofar as such authority has been delegated to ERA, to approve the construction and operation of facilities, and with respect to natural gas imports, the place of entry.

Pipeline connections already in existence at the border (one U.S. company had an import contract for 20 years with PEMEX that expired in 1977) are being used to deliver the Mexican gas. Mexico has and should continue to have an excess supply of natural gas, and exporting it to the United States via pipeline is the most economical use of this surplus.

The major significance of the current agreement is manifested in the cancellation of the proposed 42-inch pipeline branch from San Fernando to the border town of Reynosa. This restricts possible future deliveries of natural gas from Mexico to the capacity of the existing facilities, estimated to be able to deliver about 300 to 500 MMcf/D, until further bilateral arrangements are made to expand deliverable capacity. The new contract further restricts deliveries of gas to 300 MMcf/D unless new facilities are constructed. This covenant may be changed by mutual agreement; however, it appears that Mexican gas imports will be minimal until further political and capital investment issues are resolved.

These issues include the decision to export significantly larger quantities of natural gas to the United States. The necessity to recover the capital investment required for a new pipeline will make a reasonably long-term commitment necessary, require determination of about how much gas Mexico may be willing to sell to the United States over this period, and among additional considerations, will necessitate closer bilateral relationships with Mexico. The adverse effect of the situation is that significantly increased quantities of Mexican gas are delayed until these issues are resolved.

CONCLUSIONS

Supplemental oil and natural gas supplies from Mexico could partly compensate for declining domestic production and help slow growing U.S. dependence on OPEC.

Given Mexico's proved oil and natural gas reserves and the promising potential for future discoveries, it is evident that reserves should not limit oil or natural gas production through the decade. However, production levels will not be determined solely by resource availability. The Mexican government has indicated its preference for a conservative oil and gas production policy which it believes will best serve the country's objectives of developing all segments of the economy and providing employment, without causing rampant inflation.

The United States will probably receive increased oil supplies from Mexico due to increased production. As a result, Mexico will become a primary source of U.S. oil imports over the next decade. With respect to natural gas, increased associated gas production should result in more gas than Mexico can consume and this surplus gas will be exported to the United States.

CHAPTER 5

POTENTIAL OIL AND NATURAL GAS FROM ALASKA, CANADA, AND MEXICO WILL ONLY PARTIALLY SOLVE THE U.S. SUPPLY PROBLEM DURING THE 1980s AND 1990s

The gap between U.S. consumption and production of conventional oil and natural gas is expected to continue, even widen, during the 1980s and 1990s. This situation appears likely even assuming that energy consumption does not exceed 1978 levels. The gap would be exacerbated to the extent 1978 consumption levels are exceeded.

Although Alaska's resources look promising and increased Alaskan production could help offset the anticipated decline in domestic production, minimum time requirements for development will constrain this contribution even if exploration and transportation systems are expedited. Furthermore, the decline in domestic production does not appear to be susceptible to correction by synfuels development during the 1980s and 1990s because of the long lead times needed to establish commercially viable facilities on a large scale. Unconventional gas production (especially tight sands, Devonian shales, and coal bed methane) appears to offer higher potential for development during this century.

Assuming 1978 consumption levels, the decline in domestic production could be offset by maximizing oil and gas imports from our contiguous neighbors. This also assumes the unrestricted availability of Mexican and Canadian oil imports, the timely development of Alaskan resources, and maintenance of traditional import sources (including OPEC).

The "bottom line" is that import dependency will remain with us through the 1980s and 1990s, and the United States will have to work harder to conserve and to increase our domestic production of energy, especially oil and gas, as much as possible until our long-range energy objectives of renewable and inexhaustible energy sources are attained. Any import dependency no matter what or how many source countries, is undesirable, but our contiguous neighbors, Canada and Mexico, offer an alternative to added OPEC dependency and because of their proximity to the United States are more desirable sources from the standpoint of national security. It should be recognized, however, that the relief they have to offer is limited.

CURRENT SUPPLY AND CONSUMPTION

Historically imports have filled the gap between domestic production and consumption. Using 1978 as an example, domestic refined petroleum product consumption was 18.73 MMB/D, of which about 10.1 MMB/D was produced domestically. The difference, approximately 8.67 MMB/D (about 46 percent of the total) was supplied by imports. In the same year, the United States consumed 19.7 Tcf of natural gas, of which 0.97 Tcf, or about 5 percent, was imported. Almost all of the imported natural gas was supplied by Canada.

Consumption of refined petroleum products in the United States rose from 14.70 MMB/D in 1970 to 18.73 MMB/D in 1978. In the same period natural gas consumption had declined from 21.14 Tcf in 1979 to an estimated 19.41 Tcf in 1978. The trend indicates that refined petroleum products consumption has grown at the annual rate of about 3 percent. Successful conservation programs, declining supplies, and/or the impact of escalating prices may limit the growth rate to 2-1/2 percent or less over the next 10 years. Some recent studies are projecting growth rates of just over 1 percent per year.

Our analysis of domestic oil and natural gas production concludes that, after declining at a fairly steady 2 percent a year, domestic crude oil production will stabilize, or even increase slightly, by the end of the century. The methodology used is based on analysis of engineering factors such as the physical characteristics of our domestic oil and gas resource base, the potential of improved recovery technologies, and estimates of future producing rates, and includes economic and environmental factors as well as the physical and technical factors of commercially exploitable reserves. During the period 1980 to 1990, domestic production is projected to decline from 9.9 MMB/D to about 8.0 MMB/D, hold at that level through the mid-1990s, and begin rising slightly from then into the next century. 1/ This is a decline of 19 percent over a 10-year period. Our report included estimates of the production potential of lower 48 onshore sources, Alaskan sources, and enhanced oil recovery (which is defined as production beyond the conventional primary-secondary recovery in existing fields).

During the same 10-year period, U.S. natural gas production, according to our report, will continue to decline from 18.4 Tcf a year in 1980 to 16.8 Tcf a year in 1990. This

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1/Other estimates project from 6 to 8 MMB/D of conventional domestic production in 1990, and as little as 3 MMB/D to about 6 MMB/D in 2000.

represents a fall in production of 8.7 percent, or almost a 1 percent a year decline in production. This estimate takes into account associated and nonassociated gas, lower 48, frontier Outer Continental Shelf, and Alaskan gas production.

Oil production and consumption

As previously noted, in spite of increased drilling efforts, we expect domestic production to decline to about 8.0 MMB/D by 1990, before rising only slightly from then into the next century. The gap between domestic production (10.1 MMB/D) and consumption of petroleum products (18.7 MMB/D in 1978) is expected to widen, even in the event that energy consumption never exceeds 1978 levels. Under our set of assumptions, demand for imported oil can be expected to increase by about 2 MMB/D by 1990 even if consumption holds constant, due to the decline in domestic production.

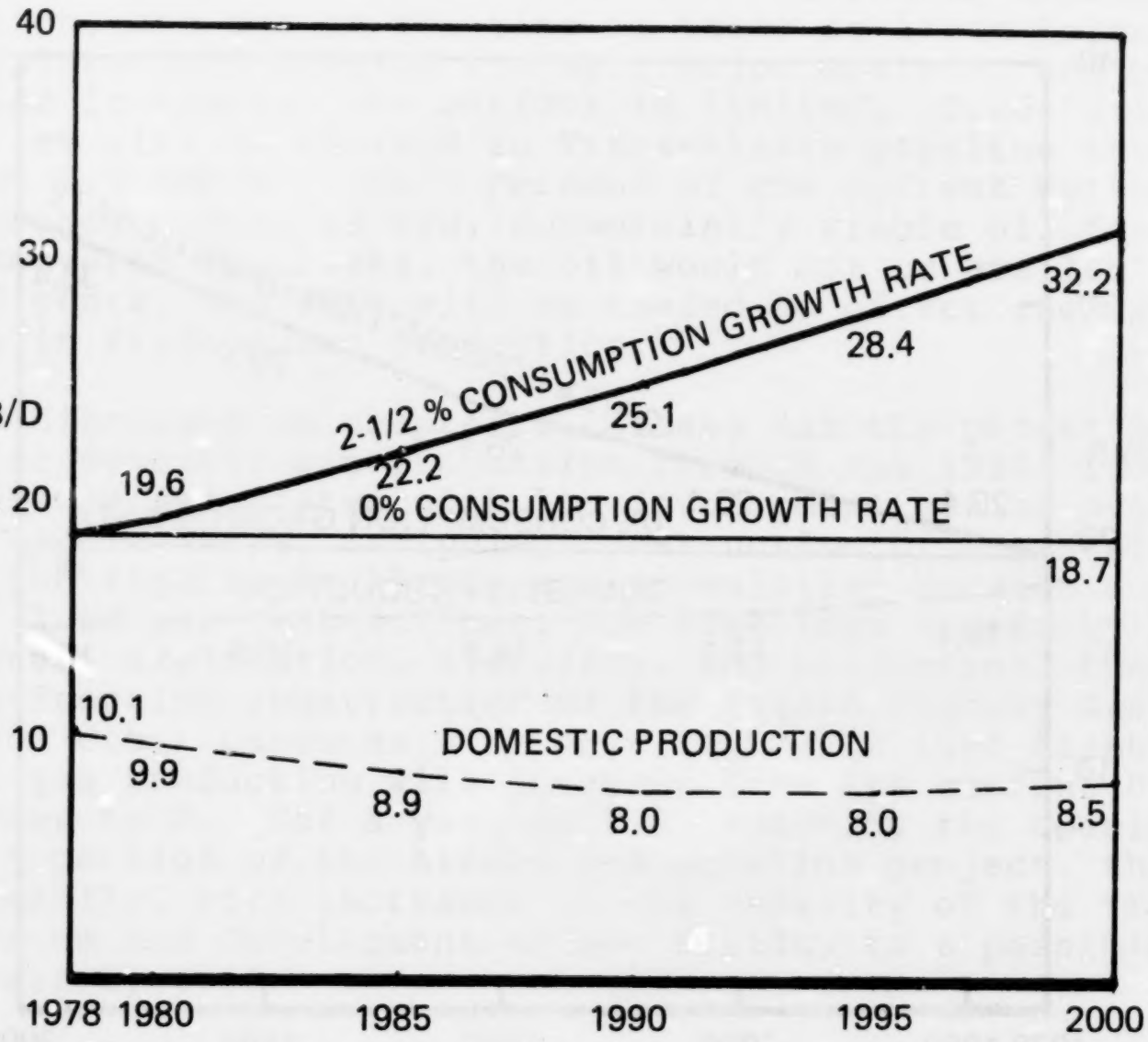
Using a 2-1/2-percent annual increase in consumption of oil products, total annual consumption rises from 18.7 MMB/D in 1978 to 32.2 MMB/D by the year 2000. Domestic production falls from 10.1 MMB/D in 1978 to 8.0 MMB/D in 1990, remains level through about 1995, then increases to about 8.5 MMB/D by 2000 (depending largely on how the Alaskan dilemma is resolved.) The gap between domestic production and consumption widens from 1978's 8.6 MMB/D (46 percent of total consumption) to 23.7 MMB/D (74 percent of total consumption) in 2000. The results are shown in figure 5.1.

Natural gas production and consumption

Our findings with respect to natural gas are similar to those for oil. To reiterate, in 1978 the United States consumed an estimated 19.4 Tcf of natural gas. Domestic production of natural gas in the U.S. is expected to decline at a rate of about 1 percent a year, from 18.8 Tcf in 1978 to about 16.8 Tcf in 1990, and still further to about 16.6 Tcf in 2000. The current gap between domestic production and consumption is being filled by imports, which come essentially from Canada. Even if the United States were to hold consumption constant at the 1978 level through 2000, dependence on imports would grow from about 5 percent to about 15 percent as a result of projected declining domestic production. Figure 5.2 illustrates this projection.

FIGURE 5.1

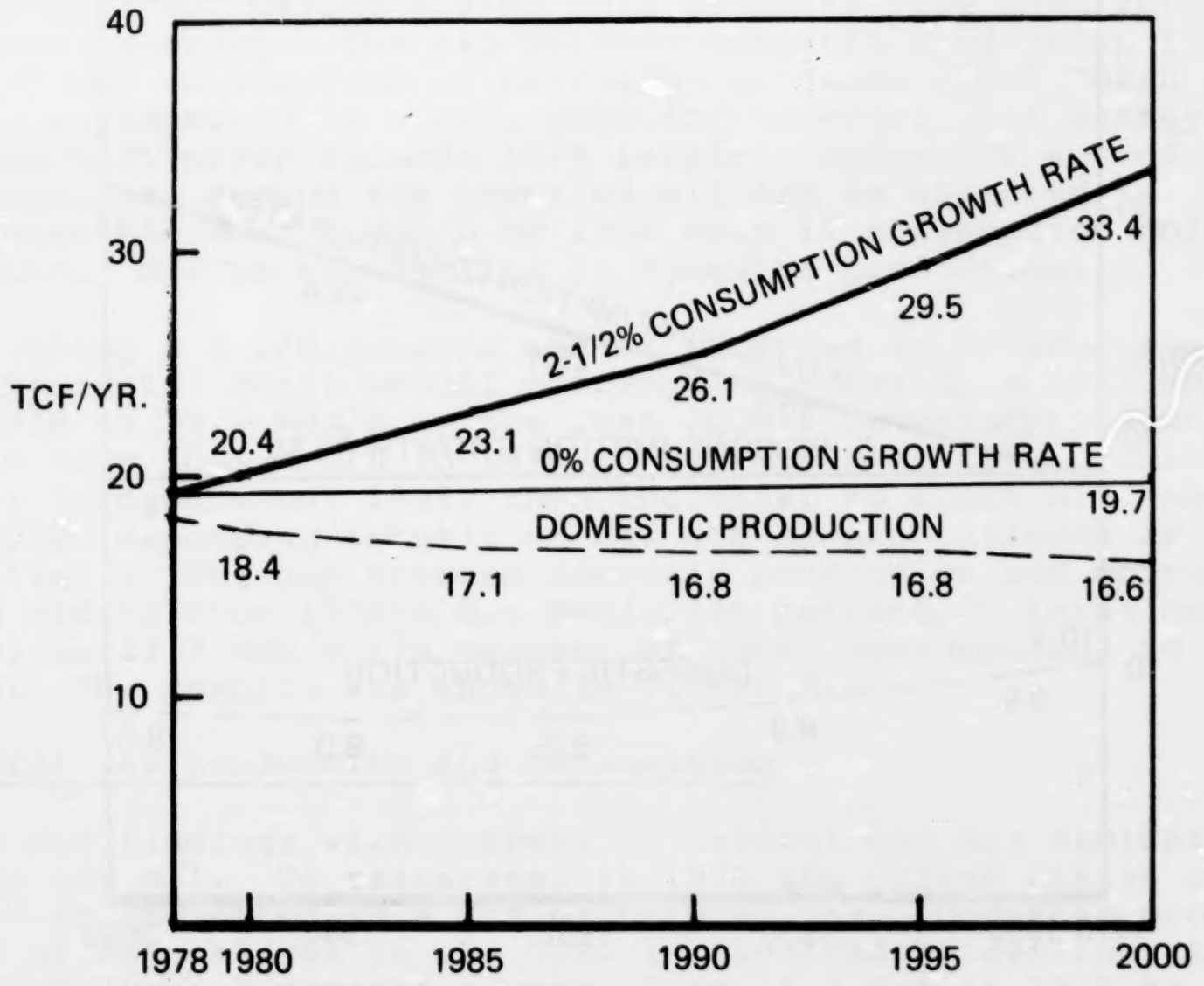
ESTIMATED TRENDS IN U.S. PETROLEUM CONSUMPTION AND PRODUCTION ASSUMING 0% AND 2-1/2% ANNUAL CONSUMPTION GROWTH RATES --1978-2000 (MMB/D)



	1978	1980	1985	1990	1995	2000
ANNUAL CONSUMPTION:						
2-1/2% GROWTH	18.7	19.6	22.2	25.1	28.4	32.2
0% GROWTH	18.7	18.7	18.7	18.7	18.7	18.7
ANNUAL DOMESTIC PRODUCTION	10.1	9.9	8.9	8.0	8.0	8.5

FIGURE 5.2

ESTIMATED TRENDS OF U.S. NATURAL GAS CONSUMPTION AND PRODUCTION ASSUMING 0% AND 2-1/2% ANNUAL CONSUMPTION GROWTH RATES --1978-2000 (TCF/YR.)



	1978	1980	1985	1990	1995	2000
ANNUAL CONSUMPTION:						
2-1/2% GROWTH RATE	19.7	20.4	23.1	26.1	29.5	33.4
0% GROWTH RATE	19.7	19.7	19.7	19.7	19.7	19.7
ANNUAL DOMESTIC PRODUCTION	18.8	18.4	17.1	16.8	16.8	16.6

Using a 2-1/2-percent annual growth trend, 1/ the 0.95-Tcf, or 5-percent, imported gas figure for 1978 rises to about 16.8 Tcf, or about 50 percent of a projected 33.4-Tcf annual consumption in 2000. (See fig. 5.2.)

ALASKA'S POSSIBLE CONTRIBUTION

Alaskan oil will help offset the decline in domestic production, but due to the time it takes to issue leases, perform exploration, develop transportation systems, and produce oil found in Alaska, the outlook is limited. Crude oil deliveries will be limited to Trans-Alaska pipeline throughput of about 1.5 MMB/D (5 to 7 percent of the current United States daily usage). Even if new, commercially viable oil fields are discovered in Alaska, the oil would not be available for 8 to 10 years, and some will be needed to offset the expected decline in Prudhoe Bay production.

As discussed in chapter 2, Alaska has the potential to stabilize domestic gas production through the 1990s if all the problems associated with its development can be overcome by the middle 1980s, including construction of a gas pipeline. Production figures in Alaska are speculative because of Government land use restrictions, the time lags caused by leasing procedures, exploration, discovery, and production, the problems confronting construction of the Alaska Highway Gas Pipeline, and other concerns. We have estimated that Alaska's natural gas production will increase from its current 0.2 Tcf a year to 0.7 Tcf a year in 1985 assuming the opening of the southern portion of the Alaska gas pipeline project, then grow steadily, with increases in the capacity of the transmission system and development of new fields, to a possible 3.6 Tcf a year by 2000.

Production in the lower 48 is expected to decline steadily from the current production of 18.7 Tcf a year to about 13 Tcf a year. Even under optimal circumstances Alaskan production will not be able to offset this anticipated decline of about 5.7 Tcf a year completely, but if certain restrictions and problems delay or preclude significant new Alaskan production, domestic natural gas production will decline at a faster rate than we have projected.

1/The 2-1/2-percent growth rate assumes 3-1/2 percent growth in GNP. Recent studies by Shell and Exxon project 1.1 percent and 2.5 and 2.7 percent growth in GNP, respectively, through 1990.

It will be at least the mid-1980s before construction of the Alaskan gas pipeline is complete. Significant production of Alaskan natural gas over the about-0.2-Tcf-a-year current level is very unlikely through 1985, and may not be possible until 1990 given the constraints of high costs and hostile environment.

LITTLE NEAR- OR MID-TERM HELP FROM NEW TECHNOLOGIES FOR OIL

The United States cannot anticipate significant contributions from new technologies in the production of oil until the late 1990s. The reasons for this limited contribution vary with individual technology, but include in most cases as primary causes the uncertainties of the technology development, market complexities, production costs, environmental questions, continuing changes in the world oil market, and possible fluctuations in conventional oil supplies. Resolution of these problems as they relate to each new technology has the combined impact of effectively postponing major contributions from these new technologies into the next century.

Unconventional oil, such as heavy crude, oil shale, coal liquefaction, and ethanol fuels, could substitute for oil in large quantities at higher levels of world oil prices. These sources have not, however, been generally considered competitive at current world oil prices, and in several cases, the technologies are not sufficiently refined for commercial development within a predictable mid-term time frame. Although anticipated price increases will provide greater economic incentive for development than has existed, our estimate is that commercial development of unconventional hydrocarbons will not be significant until after 1995, perhaps longer, because of the lead times necessary to establish widespread use, even after the technical problems are satisfactorily resolved. Ultimately recoveries could be quite large, but potential production levels are uncertain.

For example, the United States has extensive unconventional heavy crude resources. Actual recoverable reserves hinge on technology, production costs, oil pricing and the development of markets. Oil shale is another example. Two large oil shale projects on Federal lands are already underway. The results of these projects are expected to provide vital information about environmental problems and production costs by 1981 or 1982. These technologies remain uncertain, however, and industry has not been making large-scale investments in oil shale technology. The Department of Energy has various tax and incentive programs under consideration which may help attract industry interest.

According to a report prepared for the Senate Budget Committee Task Force on Synthetic Fuels, there is only one coal liquefaction technology ready for commercial application (defined as ready for engineering design)--indirect liquefaction. 1/ It will not be ready for commercial design until sustained operations have been tested in large pilot plants. DOE's objective is to demonstrate coal liquefaction by the mid-1980s so that commercialization would be feasible in the 1990s. Development of synthetic oil does represent a significant opportunity to offset potential increases in import dependency with highly desirable domestic sources of oil. Due to the uncertainties of technological and economic development, any projection of future synthetic production is subject to considerable variation.

THE MID-TERM OUTLOOK FOR UNCONVENTIONAL GAS SOURCES IS MORE OPTIMISTIC

In a recently issued report, we discussed the potential of unconventional sources of natural gas to help maintain overall domestic production levels as supplies from conventional gas sources decline. 2/ Our report concludes that oil imports could be reduced and domestic gas production increased if additional gas production is obtained from unconventional gas sources. Unconventional gas resources include Devonion shales, tight sands, coal bed methane, and methane from geopressured zones.

We reported that unconventional gas resources can contribute to future domestic supplies and help maintain overall production levels. Gas from eastern Devonion shale and western tight sands is the chief potential contributor to unconventional gas production in the mid-term.

As much as 1 Tcf per year can be produced from Devonion shales in the 1990s according to the Office of Technology Assessment and another report prepared for the Department of Energy. 3/ This compares with current production estimated

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1/Report prepared by the Rocky Mountain Division of the Pace Company, Consultants and Engineers, Sept. 5, 1979.

2/"Help for Declining Natural Gas Production Seen in the Unconventional Sources of Natural Gas," EMD-80-8, Jan. 10, 1980.

3/Lewin and Associates, Inc., "Enhanced Recovery of Oil and Gas," Feb. 1978.

at about 0.1 Tcf a year. Current annual production from the tight sands areas is over 0.85 Tcf, and it has been estimated in the report prepared for the Department of Energy that as much as 7.7 Tcf of natural gas could be produced annually from 14 of the 20 major identified basins by 1990. Just as with oil, however, economic and technical uncertainties must be resolved to realize this large an increase in production from these two sources.

Some coal bed methane production appears feasible with price decontrol, but further development and demonstration appears necessary to attract widespread industry or community interest. And due to the uncertainty of geopressured methane's potential, this resource is too speculative to depend on as a major contributor to the Nation's energy supplies at this time.

The potential 8.7-Tcf annual production forecasted for the 1990s represents a potential increase in domestic gas supplies of almost 45 percent of 1978 consumption. An increase in production of this magnitude, if realized, would be sufficient to replace the entire decline in conventional natural gas production, lock out all natural gas imports, and support better than a 2-percent growth rate in natural gas consumption. However, we believe such an increase in production is overly optimistic.

OIL AND GAS IMPORTS FROM CANADA AND MEXICO

Both Canada and Mexico have declared policies to meet domestic needs first from energy sources produced, and to export surplus production. Canada's policy includes its intent to sell its surplus at the highest attainable prices, and Mexico has declared the same intent by its actions. The implication is that the United States will pay the world price for oil. Price is still largely a matter of negotiations, subject to the politics of the nations involved, and rationalized by theories such as substitutability of fuels and rolled-in pricing. The detailed analysis of Canada's potential contribution can be found in chapter 3, and Mexico's in chapter 4.

Oil imports

We estimate that the United States will continue to receive about 155,000 barrels a day from Canada of mostly heavy crude, supplying Northern Tier refiners through about 1985. Canadian oil imports are of regional importance, even though the quantity is of little national significance. Because of the Canadian National Energy Board's announced intention to

phase out oil exports to the United States, it becomes necessary to replace Canadian imports to Northern Tier refiners by the time the current supplies are further curtailed. If Northern Tier refiners are to be supplied by Alaskan oil as recommended by DOE, selection and construction of a west-to-east pipeline system should be expedited. 1/

Mexico's contribution is more speculative. Development of Mexico's reserves is closed to outsiders, leaving PEMEX, the national oil company, as the virtual sole source of information regarding the discovery, development, and production of oil and natural gas. Our review of several estimates of potential exports from Mexico has produced a fairly wide range of possibilities, as discussed in chapter 4. Projections for Mexico are complicated by the inability to verify PEMEX's pronouncements on reserves and production schedules, and, as a developing nation, internal consumption estimates are speculative (particularly so with regard to population problems). Mexico's policies are complex, being keyed to its presidential elections (every 6 years), and contain pronouncements to limit exports to the United States to 60 percent of total exports. These limitations on energy data have caused many analysts to curtail projections of Mexico's oil development to the short term. None of the projections we reviewed go beyond 1990, and most forecasters consider that too far in the future for speculation.

Summary of Canadian and Mexican oil imports

Our estimates of imported oil from Canada and Mexico are presented in figure 5.3. For illustrative purposes we have assumed two annual consumption rates--1978 levels remain constant, and a 2-1/2-percent compounded growth rate occurs--and have compared them to projected supplies. The supply sources include domestic production, Canadian and Mexican imports, and an estimate for other imports subject to the administration's ceiling of 8.5 MMB/D.

Preliminary data from the first quarter of 1980 indicates a dramatic decrease in imports from previous years. This is primarily due to the recent sharp price increases in the world oil markets, and appears to be accompanied by a falloff in the GNP growth rate. Two recent industry forecasts show revised energy consumption growth rates of 1.1 percent for 1980 to 1990, with an average growth in GNP of

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1/See our report, "The Review Process for Priority Energy Projects Should be Expedited," EMD-80-6, Oct. 15, 1979.

FIGURE 5.3

SUMMARY OF PROJECTED CONVENTIONAL OIL SUPPLIES RELATIVE TO ASSUMED CONSUMPTION LEVELS --1978 - 2000
(MMB/D)

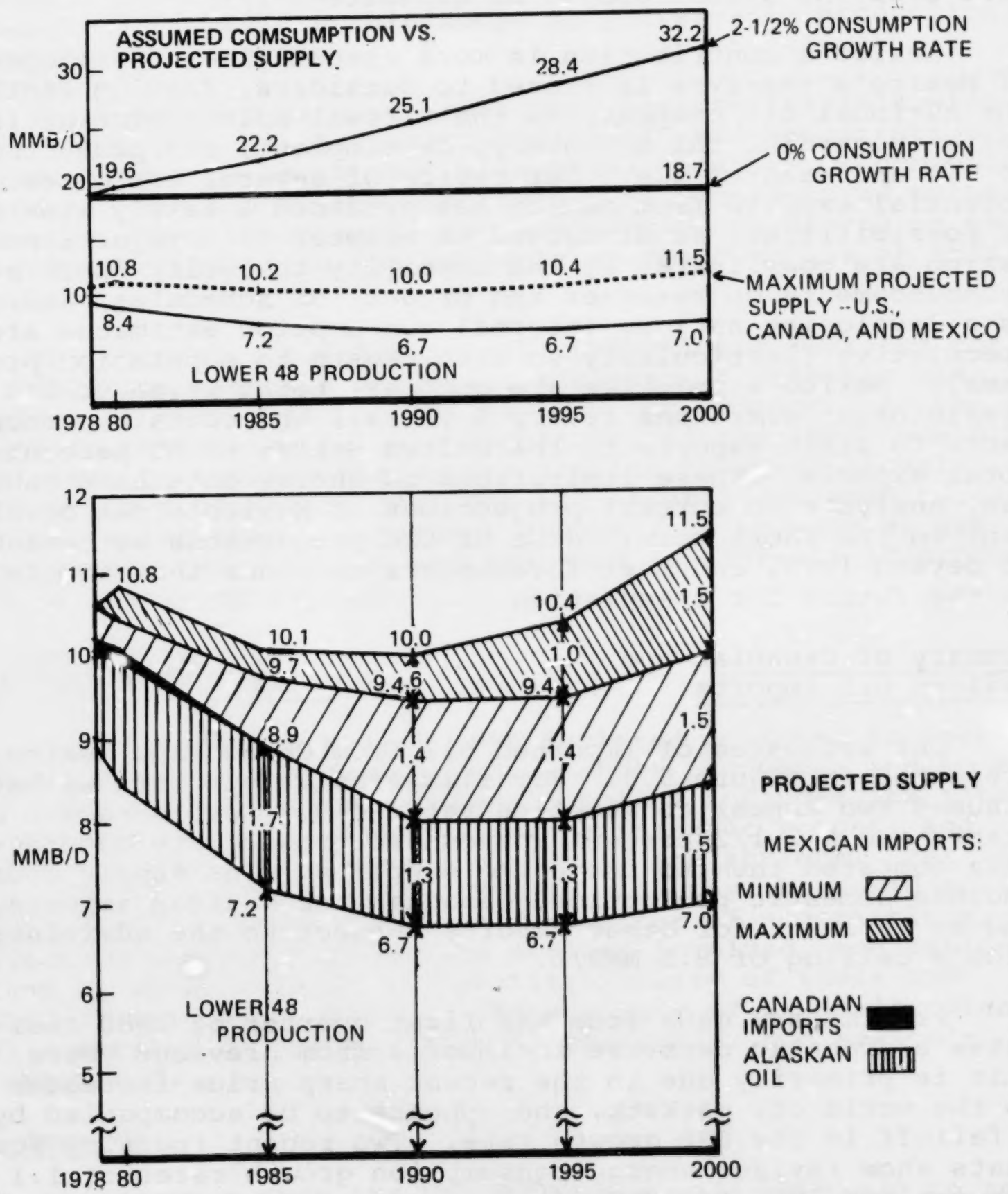

FIGURE 5.3 (cont.)

Summary of Projected Conventional Oil Supplies, Relative To Assumed Consumption Levels
(MMB/D)

YEAR	1978	1980	1985	1990	1995	2000
Annual consumption:						
2-1/2% growth rate	18.7	19.6	22.2	25.1	28.5	32.2
0% growth rate	18.7	18.7	18.7	18.7	18.7	18.7
Mexican imports:						
High	0.3	0.7	1.2	2.0	2.4	3.0
Low	0.3	0.3	0.8	1.4	1.4	1.5
Canadian imports:						
High	0.2	0.2	0.1	-	-	-
Low	0.2	0.2	0.1	-	-	-
Other imports (note a)	8.1	b/ 7.6	8.5	8.5	8.5	8.5
Domestic production:						
Alaska	1.2	1.5	1.7	1.3	1.3	1.5
Lower 48	8.9	8.4	7.2	6.7	6.7	7.0
Sub-total	10.1	9.9	8.9	8.0	8.0	8.5
Totals:						
High	18.7	18.4	18.7	18.3	18.9	20.0
Low	18.7	8.4	18.3	17.9	17.9	18.5
Variances: +/(-)						
2-1/2% growth rate:						
High	-	(1.2)	(3.5)	(6.8)	(9.6)	(12.2)
Low	-	(1.6)	(3.9)	(7.2)	(10.6)	(13.7)
0% growth rate:						
High	-	(0.3)	(-)	(0.4)	(0.2)	(1.3)
Low	-	(0.7)	(0.4)	(0.8)	(0.8)	(0.2)

a/Assumes oil imports are held to 8.5 MMB/D, with Canada and Mexico exempt.

b/Preliminary estimated data based on Jan., Feb., Mar. 1980 DOE/EIA Monthly Energy Review, May 1980.

about 2.5 and 2.7 percent, respectively. Our projections assume a GNP growth rate of about 3 percent based on the historical trend. Our estimated range of growth rate of 0 to 2-1/2 percent for oil and gas consumption is based on the historical trend with an adjustment for conservation, and is reasonable for illustrative purposes. To the extent that growth in GNP is less than 3 percent, or the higher world prices for oil decrease demand, and U.S. energy consumption falls off, there is less possibility of the United States being faced with a critical shortfall in energy supply. Figure 5.3 reflects the potential falloff of imports for 1980.

The high level for Mexico assumes that the Mexican Government will export oil to the consuming countries, regardless of political orientation, to the limits of their technical capacity, and the United States will be able to purchase 60 percent of total Mexican oil exports. The latter is based on statements by the Government of Mexico and PEMEX that Mexico would like to limit exports to the United States to 60 percent of total exports (see p. 55). Mexico may well vary from these projections; Canada's projections, however, are not expected to vary significantly.

Gas imports

The American and Canadian governments are processing applications to import an additional 3.75 Tcf of natural gas into the United States between now and 1988. We estimate that Canada has the potential to export as much as 2 Tcf of natural gas a year to the United States at the current time based on industry estimates of Canada's reserves. This amount will be steadily eroded as Canadian consumption increases, cutting the potential imports to less than 1 Tcf a year in 2000. Canada's conservative National Energy Board does not recognize this amount of reserves, thus limiting the amount of surplus natural gas available for export.

Canada's official estimates of surplus natural gas indicate that about 1.5 Tcf a year could be exported to the United States. Applications to increase imports to this level are being processed. This surplus would be absorbed by Canada'a anticipated increase in internal demand by about 1995.

Canada's willingness to increase its authorized levels of exportable surplus will be subject to political pressures within Canada, and negotiations with the United States. Therefore, we conclude that actual imports of Canadian natural gas will be higher than the current official projections. For purposes of this report we assume that imports of Canadian natural gas will increase to about 1.3 Tcf a year by 1990,

then taper off to about 0.5 Tcf by 2000 as Canadian consumption rises. Our assumption is based on the following:

--Since 1975 Canada has increased its official estimate of natural gas reserves annually, and is expected to continue to increase it in the future.

--The NEB has historically been very conservative in its estimates, and is not very likely to recognize as large reserves as industry contends exist.

--Political support for energy conservation within Canada appears to be growing, including support for saving hydrocarbon reserves for future Canadian use. This will probably also limit exports of Canadian natural gas in the future.

With regard to price, the Canadians have demonstrated a strong inclination for charging what the market will bear, and all indications are that they will continue to.

Physical production of Mexican natural gas will not be as much a constraint on deliveries to the United States as politics and transportation facilities. Mexico will produce increasing quantities of associated natural gas beyond its needs as it increases oil production. This should result in more exports of natural gas to the United States.

Mexico has begun exporting 300 million cubic feet a day (about 0.1 Tcf per year) to the United States. The bilateral contract authorizing these exports requires construction of new pipeline facilities if any increased amounts of natural gas are negotiated. Originally a 42-inch pipeline with a capacity of about 0.7 Tcf a year was planned. Today, however, there is no evidence to indicate what size pipeline might be constructed or when.

Given the surplus natural gas that Mexico will produce during the rest of this century, and the strong attraction of the U. S. market, we have assumed that these imports will increase to about 0.7 Tcf a year, or about the pipeline capacity of the existing facilities, between now and 1985 at a minimum. As an upper parameter to our projections, we have assumed construction of the previously planned 42-inch-diameter pipeline by 1985, with an attendant rapid rise of imports to 2 Tcf a year. This is a reasonable upper parameter for the time period of our projection because that is the size and approximate capacity of the pipeline that Mexico has constructed to bring associated natural gas from the Reforma fields to the city of Monterey, near the U.S. border.

FIGURE 5.4

SUMMARY OF PROJECTED DOMESTIC GAS PRODUCTION, AND CANADIAN AND MEXICAN IMPORTS RELATIVE TO ASSUMED CONSUMPTION -- 1978 - 2000 (TCF/YR.)

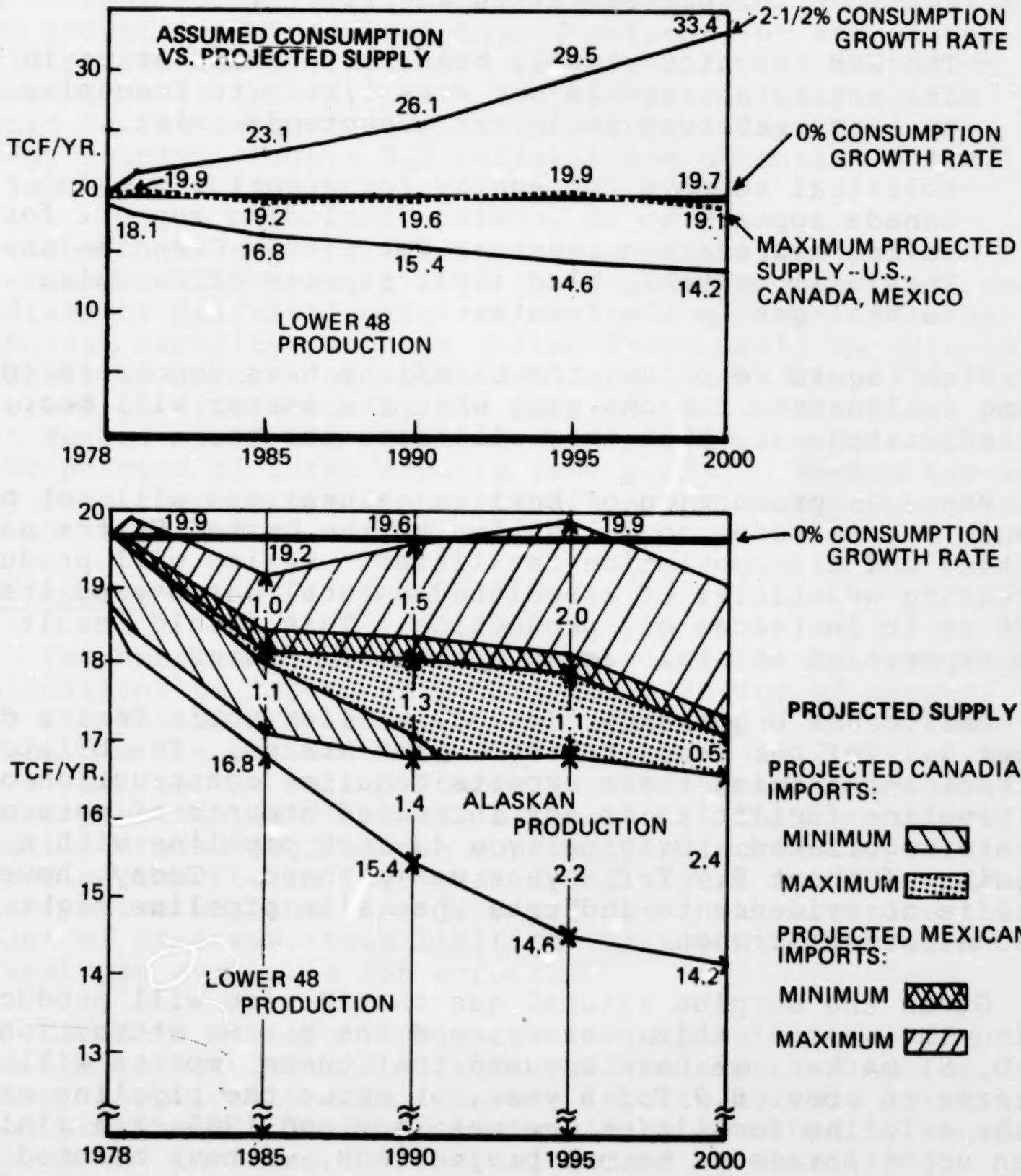

FIGURE 5.4 (cont.)

Summary Of Projected Domestic Gas
Production, Canadian and Mexican Imports
Relative to Assumed Consumption
(Tcf)

Year	1978	1980	1985	1990	1995	2000
Annual consumption:						
2-1/2% growth rate	19.7	20.4	23.1	26.1	29.5	33.4
0% growth rate	19:7	19.7	19.7	19.7	19.7	19.7
Mexican imports:						
High	-	0.4	1.0	1.5	2.0	2.0
Low	-	0.1	0.2	0.2	0.2	0.2
Canadian imports:						
High	0.9	1.1	1.1	1.3	1.1	0.5
Low	0.9	1.1	0.9	0.3	-	-
Domestic production:						
Alaska	0.2	0.3	0.3	1.4	2.2	2.4
Lower 48	18.6	18.1	16.8	15.4	14.6	14.2
Sub-total	18.8	18.4	17.1	16.8	16.8	16.6
Totals:						
High	19.7	19.9	19.2	19.6	19.9	19.1
Low	19.7	19.6	18.2	17.3	17.0	16.8
Variances: +/(-)						
2-1/2% growth rate:						
High	-	(0.5)	(3.9)	(6.5)	(9.6)	(14.3)
Low	-	(0.8)	(4.9)	(8.8)	(12.5)	(16.6)
0% Growth rate:						
High	-	0.2	(0.5)	0.1	0.2	(0.6)
Low	-	(0.1)	(1.5)	(2.4)	(2.7)	(2.9)

Mexican gas import prices may be expected to rise quarterly in relation to price increases in oil as prescribed by the bilateral gas contract.

Summary of Canadian and Mexican natural gas imports

Figure 5.4 illustrates the impact of our findings on the domestic gas supply situation by comparing the projected decline in domestic production with estimates of supplemental gas supplies from Canada and Mexico drawn from chapters 3 and 4. Two estimates are shown for each country. The lower line represents a reasonable estimate based on current facts and a conservative outlook. In the case of Mexico, we assume that no new pipeline is constructed. The second line is more speculative and requires occurrence of certain events in years to come. For example, in the case of Canada, continued increases to natural gas reserves and new agreements to replace expiring contracts are assumed. In the case of Mexico, construction of the originally planned 42-inch pipeline by 1985 is assumed; and by 1995, the capacity of this system will be doubled. This more optimistic projection ignores potential political constraints based on the theory that economic incentives tend to overpower political considerations. Therefore, regardless of political orientation, it is assumed that Mexico and Canada will find it expedient to sell natural gas to the United States to the limits of their technical capacity and economic needs.

Actual imports to the United States will most probably be between the low and high estimates for each country. This range is represented by the shaded areas on the graph.

CONCLUSIONS AND OBSERVATIONS

Alaska, Canada, and Mexico offer limited assistance in resolving our mid-term national energy problem in both oil and natural gas. In spite of the potential of Alaska, the United States must deal with declining domestic production of crude oil and natural gas through most of the 1980s and 1990s. We will have to work to conserve and to increase our domestic production of oil and gas until long-range objectives of renewable and inexhaustible energy sources are attained. Supplemental sources from Canada and Mexico could offset part of the decline in domestic production through the 1980s. This would increase our dependency on imports, however, and the immediate problem facing the United States is how to keep our existing dependence from growing.

The picture could change radically if the estimated production potential of domestic oil and gas alters

substantially in the mid-term. Except for unconventional gas resources, there is little indication that it will. However, should domestic gas supplies be 1.5 Tcf greater by 1985 due to unanticipated unconventional gas production, gas imports could be reduced by that amount or OPEC oil could be displaced on a Btu-equivalent basis. At the current contract price for Mexican gas ($4.47 per million Btu's) this contribution could rise to $6.7 billion. This is equivalent to replacing up to 750,000 barrels a day of oil imports.

We make the following observations as a result of our analysis.

1. U.S. bilateral relationships with Canada and Mexico will directly affect U.S. access to surplus production of oil and natural gas in those countries. One factor in creating the most cooperative bilateral relationships would be for U.S. policymakers to give careful consideration to the domestic energy policies of Mexico and Canada.

2. The gap between consumption and production of conventional oil and gas can be expected to widen during the 1980s and 1990s, and our import dependency can be expected to continue. This observation is made with consideration of Alaskan production, which, regardless of how promising it may appear to be, requires long lead times for production to come on line and is subject to uncertainty.

3. Concentrated effort should be made to increase our domestic production, including the development of synthetic fuels, and unconventional oil and gas resources.

4. The United States has to work to conserve more, and utilize as efficiently as possible our domestic supplies to enable us to get through the 1980s and 1990s.

5. The decline in domestic production cannot be offset by synfuels development during the 1980s and 1990s because of lead times and other constraints, but unconventional gas appears to offer more promise because several technologies are already operational on a commercial basis. We must recognize our vulnerability caused by import dependency and insure that through the Strategic Petroleum Reserve or other suitable means we have the physical ability to deal with supply disruptions.

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* U.S. GOVERNMENT PRINTING OFFICE: 1980- 620-386/298